ORDNANCE

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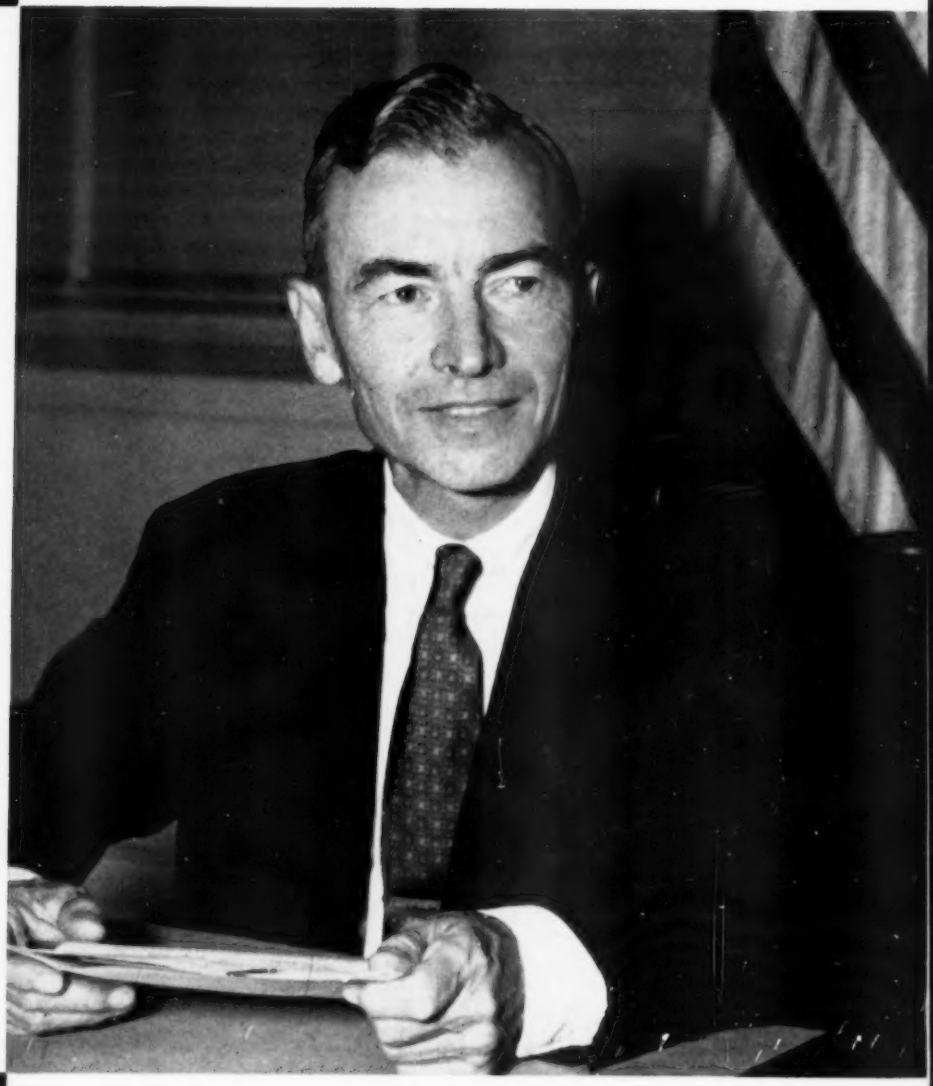
VOLUME XXXVIII NO. 201 NOVEMBER-DECEMBER 1953



DONALD A. QUARLES
Assistant Secretary
of Defense for
Research & Development

IN THIS ISSUE

Belloc—Military Historian . . . . . Hoffman Nickerson

More Power for Air Power . . . . . John A. Killick

Ordnance Maintenance in Germany . . Col. Philip Schwartz

Testing Naval Aircraft Weapons . . Capt. M. P. Bagdanovich

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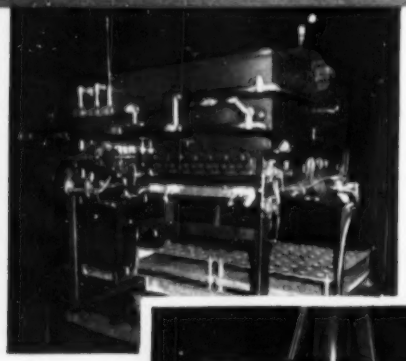
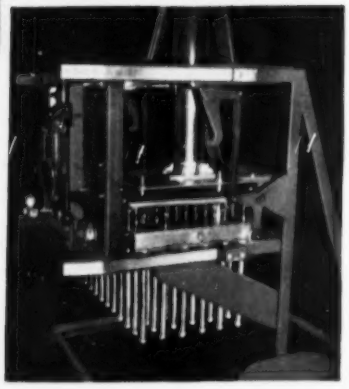


Volumetric Pouring Unit



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The Magazine of Scientific and Industrial Preparedness

Vol. XXXVIII | NOVEMBER-DECEMBER 1953 | No. 201

FEATURES

Donald A. Quarles . . . . . **Front cover**
Exclusive photograph for ORDNANCE *by Harris & Ewing*
Easy Does It . . . . . **Frontispiece**
Weapons Research 393
The dividends are great in peace as well as in war
Belloc—Military Historian . . . . . **Hoffman Nickerson** 394
A final tribute to a great writer and scholar
Transport Helicopter 398
Pictorial account of the giant Piasecki YH-16 tandem-rotor craft
Army Ordnance in Action 399
The Corps met and answered the challenge of Korea
Two Recent Ordnance Vehicles 402
Photographs of the amphibious Otter and the armored personnel carrier
Management Engineering . . . . . **Col. R. E. Peters** 403
Ordnance trains key employees to solve the specialist shortage
Ordnance Day, 1953 407
A picture story of the Thirty-fifth Annual Meeting of the A.O.A.
Ordnance Maintenance in Germany . . . **Col. Philip Schwartz** 411
Rebuilding Army equipment in the European Theater
More Power for Air Power . . . . . **John A. Killick** 415
The rôle of the Arnold Engineering Development Center
Testing the Navy's Air Ordnance **Capt. M. P. Bagdanovich, U.S.N.** 420
The work of the U. S. Naval Aviation Ordnance Test Station
Czech Military Small Arms . . . . . **Harry Wandrus** 422
The Russian influence is noted in some recent weapons
Industrial Preparedness 425
The bulletin on the progress of A.O.A. Technical Divisions and Committees
Industry-Ordnance Meeting 429
Announcement of the Association's annual Industrial Preparedness Dinner
Month by Month . . . . . **Editorial** 430

DEPARTMENTS

Atomic Energy 386
Association Affairs . . . 434
Materials Progress . . . 439
New Developments . . . 446
Communications 458
From the Record 460
Book Reviews 466
Index of Advertisements . . 535

ARMAMENT TECHNOLOGY

Training Aids . . . . . **Capt. C. C. Martin** 517
Ordnance can contribute much to their development
The Mighty Mite . . . . **M/Sgt. Roy G. Carbine, U.S.M.C.** 520
Marine Corps develops powerful truck light enough for helicopter transport
Ultrasonics in Liquids . . . . . **K. R. Newnham** 524
New high-frequency techniques have a big industrial future
Rust Prevention Today . . . . . **Joseph Szanto** 526
Volatile corrosion inhibitors improve military packaging
Amphibious Giant . . . . . **Harry A. Jacobs** 529
The BARC may replace the DUKW in ship-to-shore support
Biggest Forging 532
Pictorial account of the 110-foot steel column made by Bethlehem Steel Company
Packaging Ordnance . . . . . **Robert Dickey, III** 533
Unique steel containers assure safe transportation of fragile parts

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A Cat DW10 with No. 10 Scraper spreads earth on the run at the Contra Costa County, California, airport.

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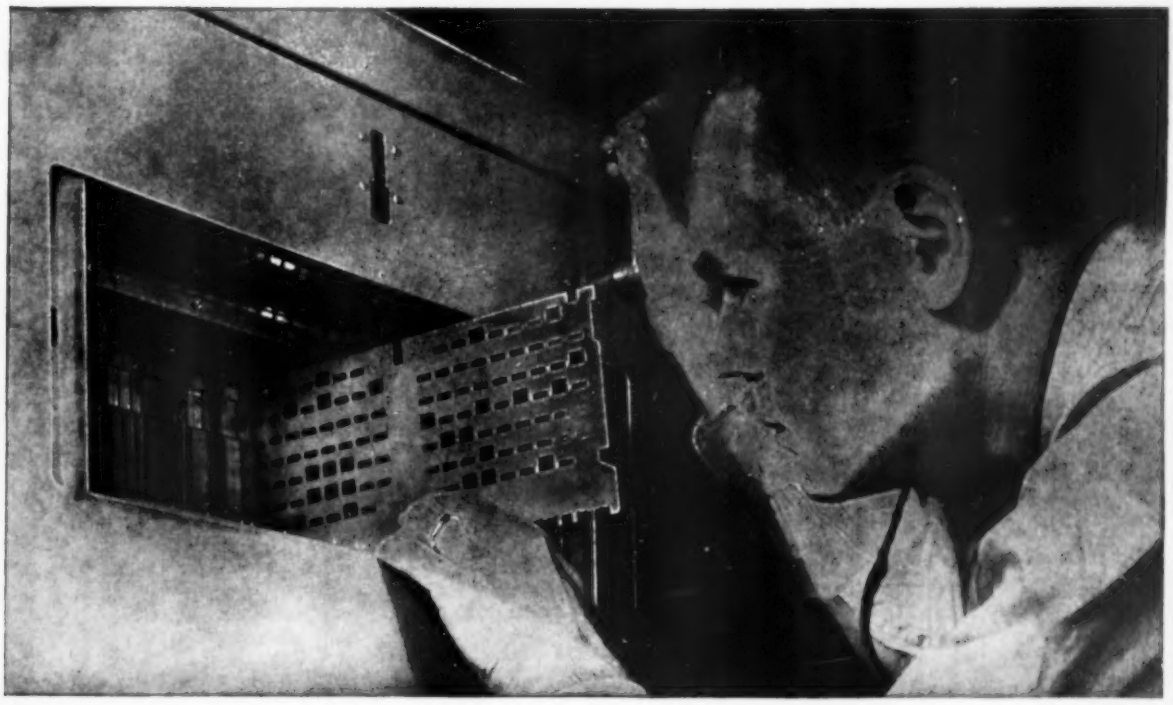
A D318 Engine powers this Koehring dragline with 1-yard bucket.



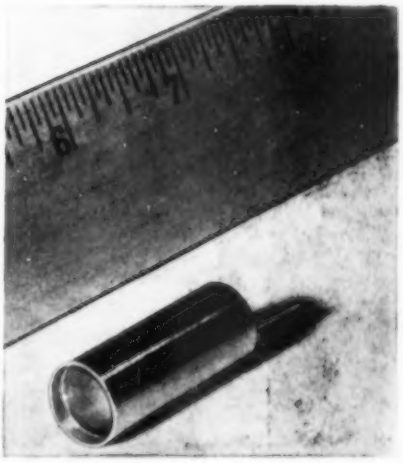
Checking perforated metal card in Bell's new "card file" which uses Phototransistors to help route Long Distance telephone calls along the best routes. If the first voice-way is in use, a "detour" is swiftly found. The equipment is known in telephony as a "card translator."

CARDS FOR CONVERSATION

To find out how to route Long Distance calls a dial system needs lots of information—fast. To provide it Bell Laboratories engineers developed a new kind of card file—one that dial systems can read.

Punched holes on metal cards tell how calls should be handled. When a call arrives the dial system "asks" the "card file" how to proceed to a particular area. Instantly the appropriate instruction card is displaced so that its pattern of holes is projected by light beams on a bank of Phototransistors. In a flash the Phototransistors signal switches to set up the best connection. Cards are quickly changed when new instructions are needed.

The "card file" will have its widest use in speeding Long Distance calls that are now dialed by a telephone operator and may one day be dialed by you personally. It is another example of how Bell Telephone Laboratories helps telephony to grow, as costs are kept down.



New Phototransistor unit. Light entering the cylinder is focused by the lens on a piece of germanium that responds by generating current. Like the Transistor, the Phototransistor was invented in Bell Telephone Laboratories.

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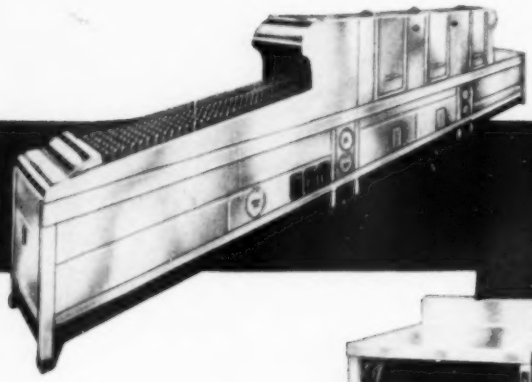

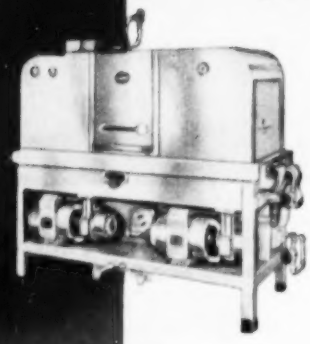

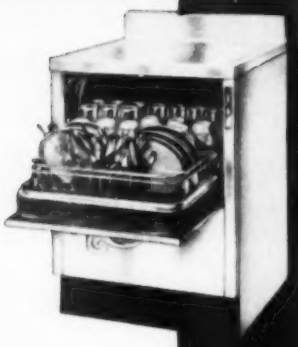

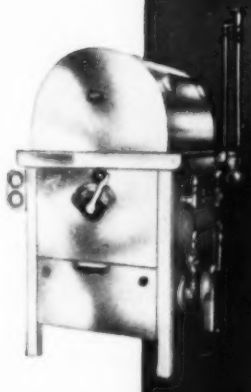

For the *right* costs and the *right* standards—put the *right* machine on the *right* job. Do you know that Hobart builds *25* models of dishwashers and glasswashers—fully and semi-automatic—with and without Hobart Time Controls—little (2 ft. square) and big (29 ft. long, Flight-type continuous racking)? They're all described and pictured in this booklet.

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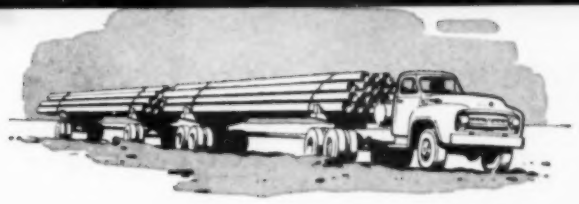
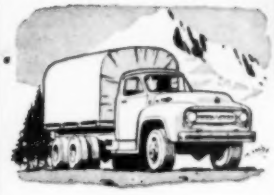


Subject: Military Vehicle Procurement



Tactical vehicles, as conceived by military engineers and executed by American industry, have long been widely acclaimed. Many people, however, do not realize the extent to which commercial-type vehicles are contributing to the efficiency of our military operations—and the ever-increasing use of such vehicles by our armed forces.

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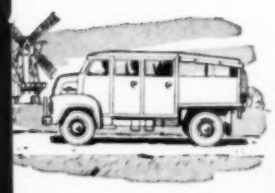

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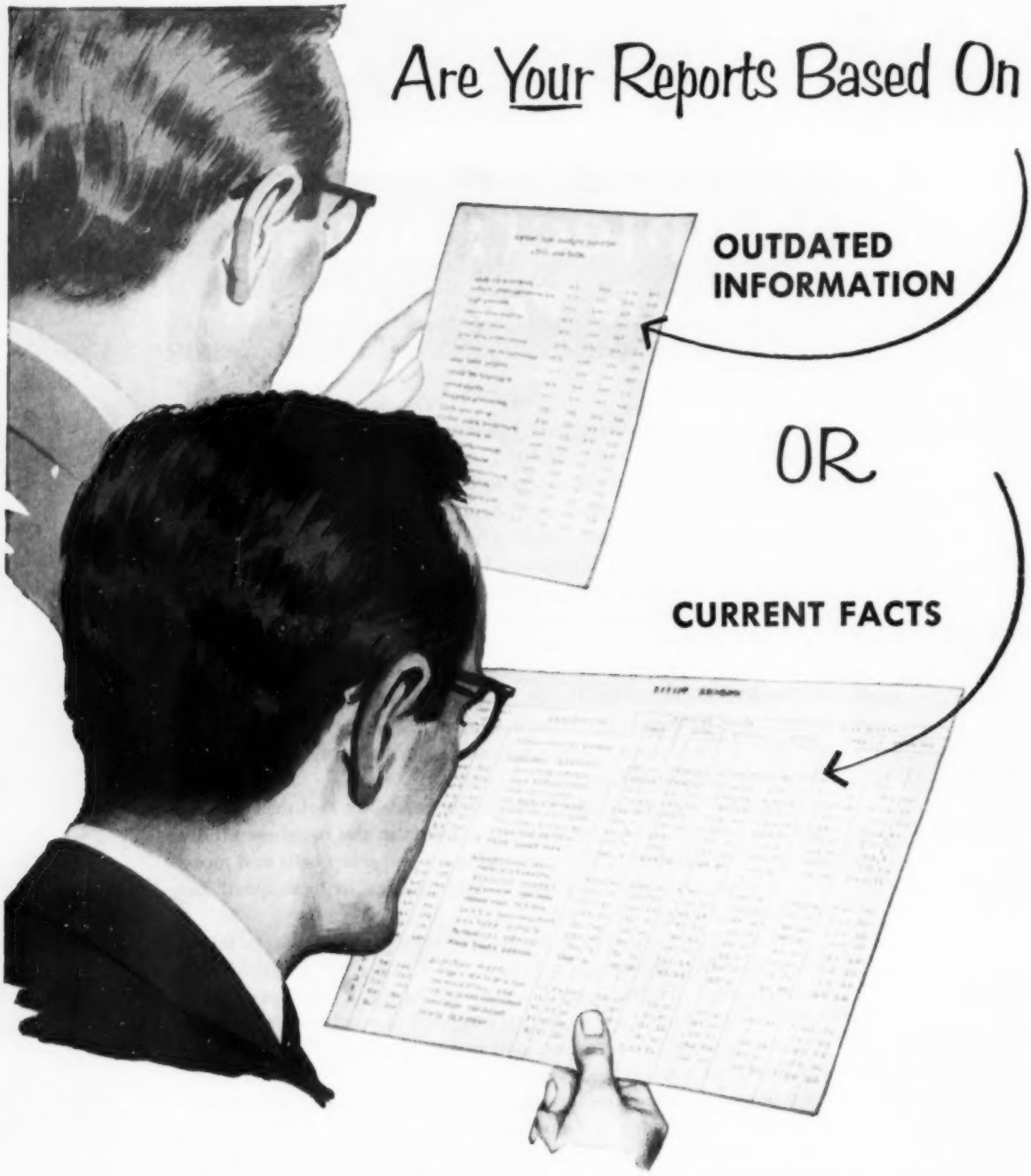

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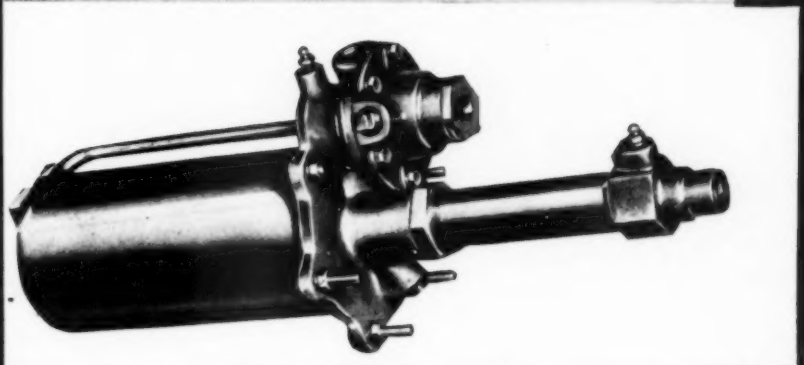

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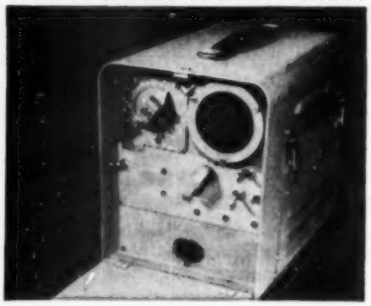

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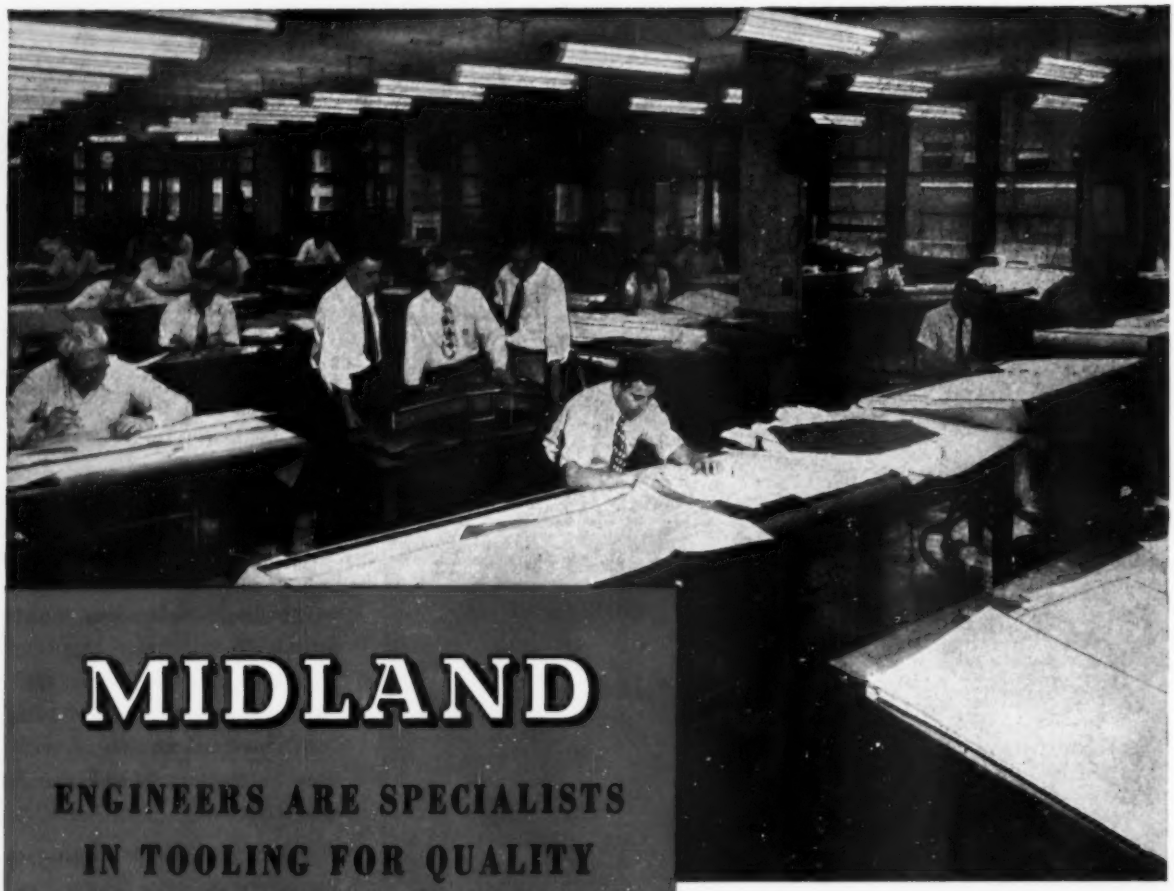

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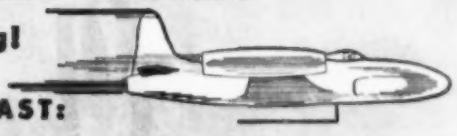

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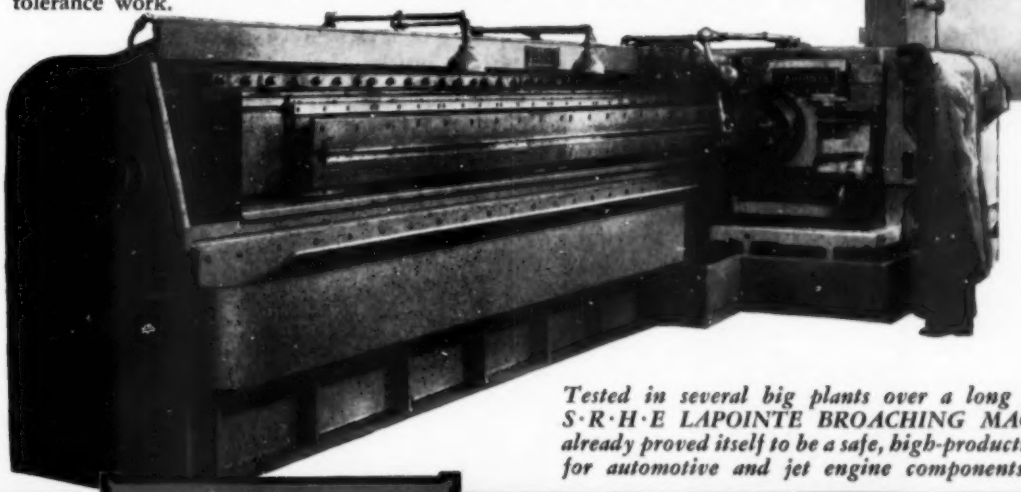

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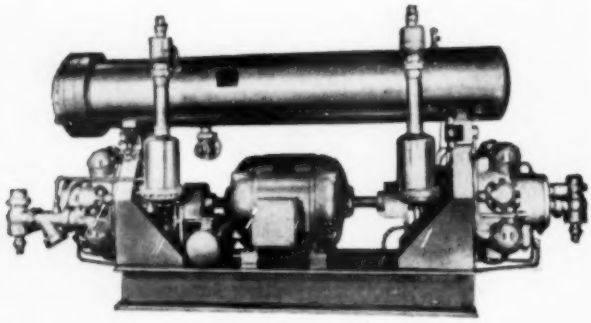
Room Air Conditioner
Fits in window, cools, filters and circulates fresh outside air. Ideal for offices, hospital convalescent rooms, workshops or other small areas.



Central Station Unit
For large installations. This unit forms the heart of many air conditioning, cold storage and other temperature and humidity control systems.

Chrysler Airtemp

HEATING • AIR CONDITIONING
***for* HOMES, BUSINESS, INDUSTRY**

Airtemp Division, Chrysler Corporation, Dayton 1, Ohio

Extending Communications

...is part of the "Blaw-Knox Job" for our Armed Forces

Since the early days of wireless telegraphy Blaw-Knox antenna towers have helped lengthen the range of military communications—even to the point of transmitting signals around the globe.

Relying upon our long experience in this field, the Armed Forces use Blaw-Knox Towers that range from collapsible mobile units and cross-country relays to "cloud scrapers" that report the weather from bleak Arctic outposts.

This engineering know-how is duplicated by many other Blaw-Knox products and services which step up production, performance and profits in such industries as —Chemical and Food Processing, Gas and Petroleum, Plastics, Ferrous and Non-Ferrous Metals, Construction, Public Utilities. The right hand column indicates the scope of Blaw-Knox. On request, we will be glad to send you descriptive literature about any product or service.

MEMBERS OF THE BLAW-KNOX "FAMILY" AND SOME OF THEIR PRODUCTS

Blaw-Knox Equipment Division
Blawnox, Pa.
- Concrete Road Paving Machinery
- Clamshell Buckets
- Contractors Equipment
- Gas Conditioning Equipment
- Open Steel Flooring
- Radio, TV and Transmission Towers
- Steel Forms for Concrete Construction
- Chemical and Process Equipment
- Water Cooled Equipment for High Temperature Furnaces

Buffalo Equipment Division
Buffalo 11, New York and Mora, Minn.
- Machinery for the Chemical and Food Processing Industries
- Specialized Machinery for the Dairy Industry

Chemical Plants Division
Pittsburgh 30, Pa.
- Complete Plants for the Chemical and Process Industries

Foote Construction Equipment Division
Nunda, New York
- Black Top Road Pavers
- Concrete Road Pavers

Lewis Machinery Division
Groveton, Pa.
- Rolling Mills and Auxiliary Machinery for Rolling Ferrous and Non-Ferrous Metals

National Alloy Division
Blawnox, Pa.
- Alloy Steel Castings for Extreme Temperatures, Abrasion and Corrosion Resistance

Power Piping and Sprinkler Division
Pittsburgh 33, Pa.
- Prefabricated Piping Systems for High Pressures and Temperatures. Pipe Hangers
- Automatic Sprinkler Systems for Fire Protection

Rolls Division
(Pittsburgh and Lewis Rolls)
Pittsburgh 1, Pa.
- Rolls for Steel and Non-Ferrous Rolling Mills

Union Steel Castings Division
Pittsburgh 1, Pa.
- Heavy Steel Castings

BLAW-KNOX

BRANCH OFFICES:

Birmingham 3, Alabama
Chicago 3, Illinois
Philadelphia 3, Pennsylvania
New York 17, New York
San Francisco 5, California
Washington 5, D. C.
Tulsa 1, Oklahoma
Export—New York 17, New York

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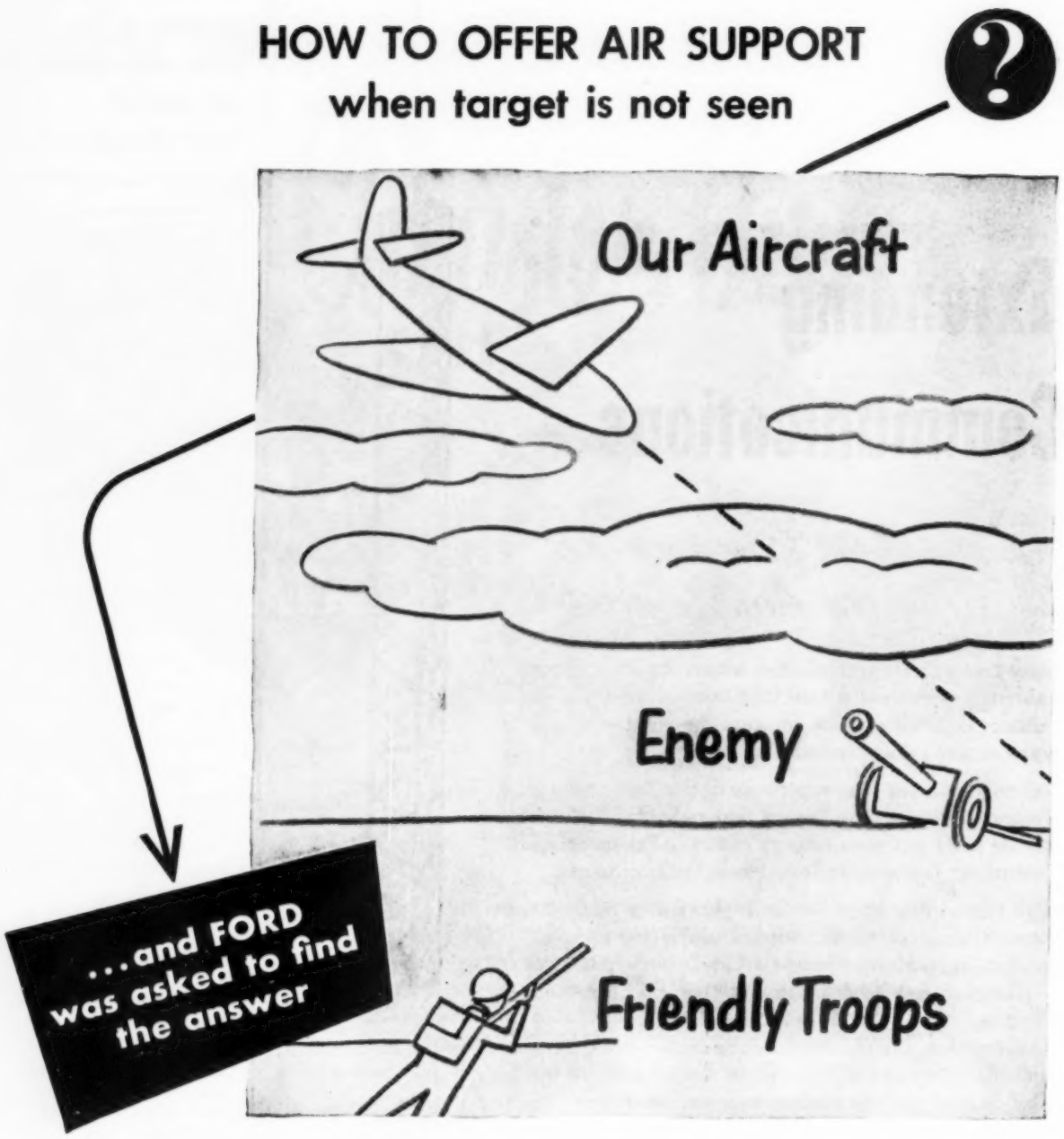
BLAW-KNOX
Company
FARMERS BANK BUILDING
PITTSBURGH 22, PA.

HOW TO OFFER AIR SUPPORT
when target is not seen



Blinding rain! Darkest night! Obscuring clouds! One of these conditions . . . or all three combined . . . deter planes from seeking out and destroying enemy strong points in support of friendly front line troops. That's why the Ford Instrument Company was called in by the Navy to design and build compact, airborne equipment to do this job.

This is typical of the problems that Ford has been given by the Armed Forces since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic, electro-mechanical, magnetic and electronic instruments that bring us our "tomorrows" today. Control problems of both Industry and the Military are Ford specialties.

You can see why a job with Ford Instrument offers young engineers a challenge. If you can qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.

8

FORD INSTRUMENT COMPANY
DIVISION OF THE SPERRY CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

★ Interchangeability

★ the TDA key to better logistics

Keeping an army on the move poses constant problems in vehicle maintenance and parts supply. TDA, working in close cooperation with the Armed Services to solve these problems, has developed the new TDA STRAIGHT-LINE DRIVE with top-mounted double reduction final drives for military vehicles with the greatest degree of parts interchangeability ever achieved.

HERE'S WHAT TDA PARTS INTERCHANGEABILITY MEANS TO MILITARY SUPPLY AND MAINTENANCE OFFICERS

1. A simpler logistics problem of stowage and palletizing.
2. Fewer different parts in stock bins—of vital necessity to the military supply officer who must maintain a warehouse on wheels.
3. Far greater ease of maintenance.
4. Fewer records of parts and service operations to maintain.
5. Reduced personnel training time in operation and maintenance.
6. More personnel made available for other duty.
7. Faster availability between manufacture and use.

For example, on the TDA-equipped 2½-ton 6x6 truck, final drives in *all three* axles are identical and interchangeable! There's only *one type* of shaft for *four* different locations. *One type* of housing for *two* different rear axle locations. *One type* of universal joint flange for *nine* different locations. To make a long story short, there are 22.8% *fewer different* parts in the running gear of the TDA-equipped 2½-ton 6x6 than the World War II truck of the same type!

Careful planning, sound engineering and close cooperation like this are helping to produce better military vehicles for a stronger America.

The Accepted TDA Standard

AXLES

TIMKEN-DETROIT AXLE DIVISION
ROCKWELL SPRING & AXLE COMPANY
Detroit 32, Michigan

WORLD'S LARGEST MANUFACTURER OF AXLES FOR TRUCKS, BUSES AND TRAILERS

PLANTS AT: DETROIT, MICH. • OSHKOSH, WIS. • UTICA, N. Y. • ASHTABULA, KENTON AND NEWARK, OHIO • NEW CASTLE, PA.

for Greater Strength with Lighter Weight

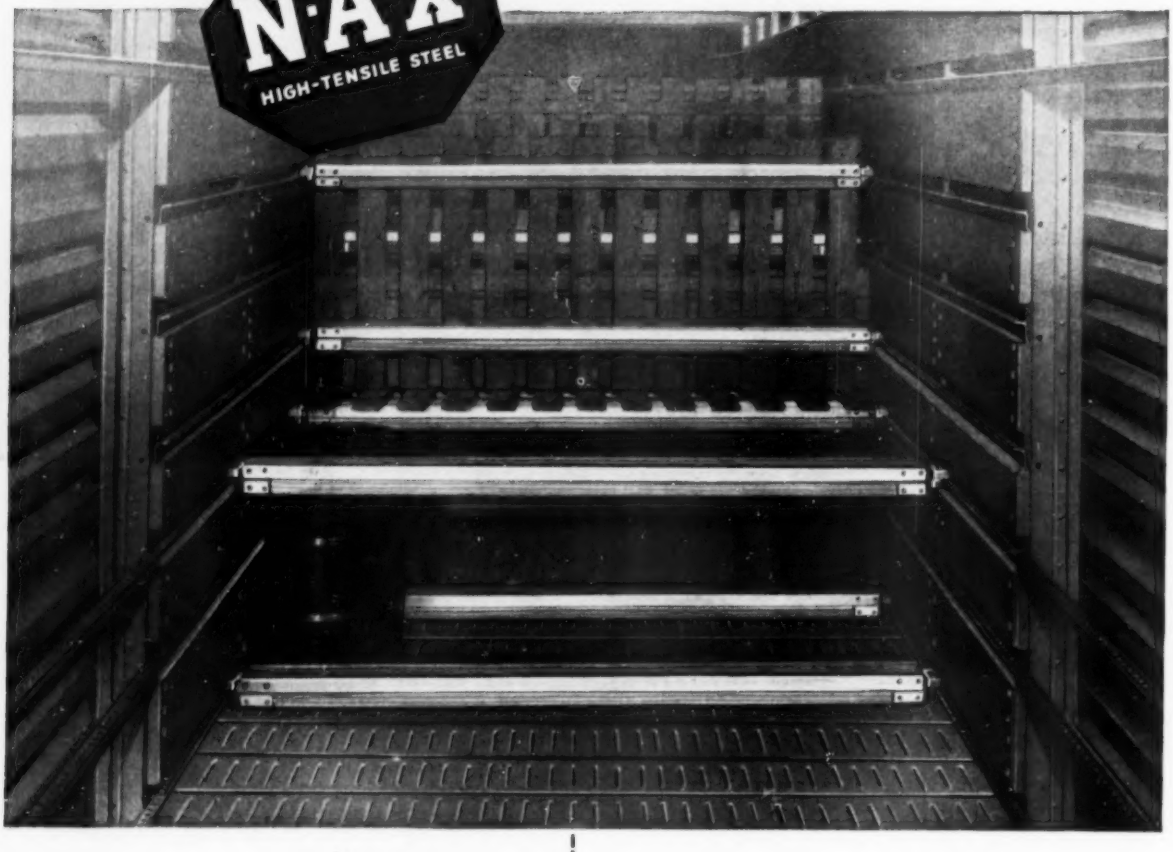
in modern material handling equipment

The increasing use of the Evans DF Loader reflects the progress of railroads toward more efficient material handling methods.

In the DF Loader there is high strength with minimum weight through the use of N-A-X HIGH-TENSILE steel. This low-alloy steel has 50% greater strength than mild carbon steel, with greater resistance to corrosion with either painted or unpainted surfaces.

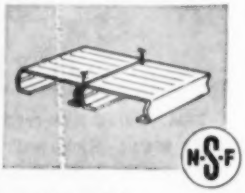
You can get the same results as Evans. Your product can be made stronger, lighter in weight and longer-lasting, when you specify N-A-X HIGH-TENSILE steel.

N·A·X HIGH-TENSILE STEEL



THE EVANS DF LOADER is a product of Evans Products Co., Plymouth, Mich. DF means Damage-Free, Dunnage-Free.

NAILABLE STEEL FLOORING for boxcars, flatcars and gondolas is made of N-A-X HIGH-TENSILE steel, and is a product of Steel Floor Division, Great Lakes Steel Corporation.



Engineering data on these products available upon request to the manufacturers.

The "Wonder Bar," a section of which is shown at left, is a vital part of the Evans DF Loader. It is a wooden bar reinforced by a Z-bar made of N-A-X HIGH-TENSILE.

The "Wonder Bar," when locked into place, secures all kinds of lading. It is strong enough to resist shifting load stresses in moving boxcars, yet so light that one man can lift it into position. The DF Loader provides real operating economies for both railroads and shippers.

Another modern product for efficient transportation equipment is Nailable Steel Flooring, also made of N-A-X HIGH-TENSILE steel.

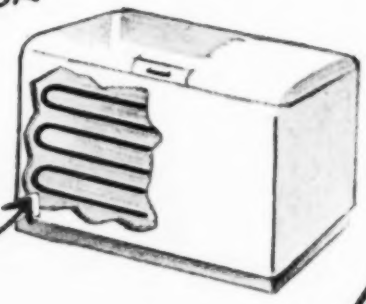
GREAT LAKES STEEL CORPORATION

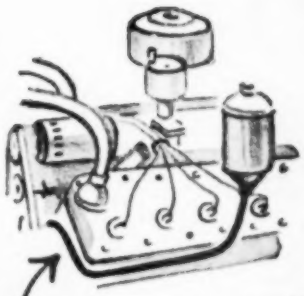
N-A-X Alloy Division — Ecorse, Detroit 29, Mich.

NATIONAL STEEL CORPORATION

FROM *the Bundy Sketchbook*
TO *jog a designer's imagination*

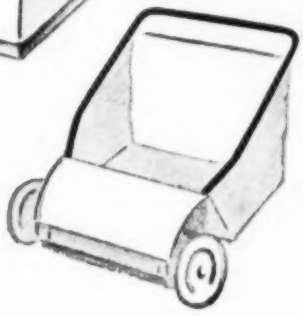
EVAPORATOR COIL FOR HOME FREEZER



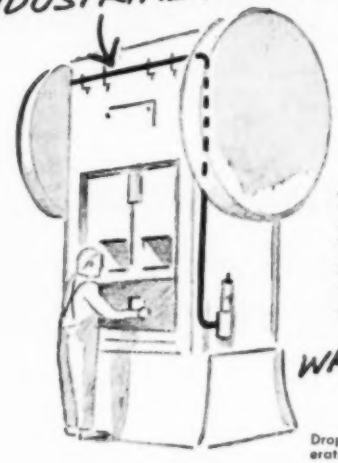


TIMING GEAR OIL LINE

FRAME FOR LAWN SWEEPER



LUBE LINES ON INDUSTRIAL PRESSES



REMARKS Perhaps you can improve your product -- with Bundyweld Tubing. For instance, you can end tubing-leakage worries. Or make your product lighter and stronger. Perhaps you can bring production costs down, too. Talk things over with our engineers.

WRITE to us for catalog or for specific information on your problem. BUNDY TUBING COMPANY, DETROIT 14, MICH.

Drop in to see us at our exhibit in the Eighth All-Industry Refrigeration and Air Conditioning Exposition in Cleveland, Nov. 9-12.

Bundyweld Tubing

® DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof
High thermal conductivity
High bursting point
High endurance limit
Extra-strong
Shock-resistant
Ductile

Lightweight
Machines easily
Takes plastic coating
Takes plating
Bright and clean
No inside bead
Uniform I.D., O.D.

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . . continuously rolled twice around laterally into a tube of uniform thickness, and passed through a furnace. Copper coating fuses with steel. Result . . . Bundyweld, double-walled and brazed through 360° of wall contact.

← NOTE the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rufan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave., South • ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., East • ***Bridgeport, Conn.:*** Karhumel Steel & Aluminum Co., 117 E. Washington St. • ***Los Angeles 58, Calif.:*** Tubesales, 5400 Alcoa Ave.

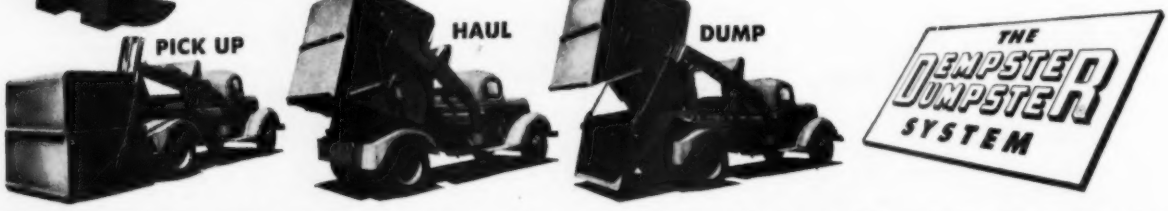
Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.

You will Dump High Costs, too..

. . . when you install the Dempster-Dumpster System of Bulk Materials Handling

Manufacturers over the nation have learned to eliminate the costly and inefficient method of handling bulk materials with conventional dump trucks, drivers and loading crews. You can equip one truck with a hydraulically operated Dempster-Dumpster. Then, inside or outside buildings at convenient accumulation points, you simply place detachable Dempster-Dumpster Containers, in capacities up to 4 times that of conventional dump truck bodies, with each designed to suit the materials to be handled—be they solids, liquids or dust . . . hot or cold . . . bulky, light or heavy. Containers shown at left, all handled by one Dempster-Dumpster, are only a few of the many available or that can be built to meet your needs. The Dempster-Dumpster, operated by only one man, the driver, serves scores of containers . . . one after another, as shown below.

You eliminate trucks standing idle. You eliminate re-handling of materials. You eliminate loading crews. You increase efficiency, sanitation and good plantkeeping with this Dempster-Dumpster System—the lowest cost method of bulk materials handling ever devised. Write to us for complete information. Manufactured exclusively by Dempster Brothers, Inc.



DEMPSTER BROTHERS, 9113 Shea Bldg., Knoxville 17, Tennessee

This trade mark on rockets, shells, fuzes

and other ammunition metal components
assures the armed forces of highest quality,
delivery as promised and fair price.

HECKETHORN MANUFACTURING AND SUPPLY COMPANY

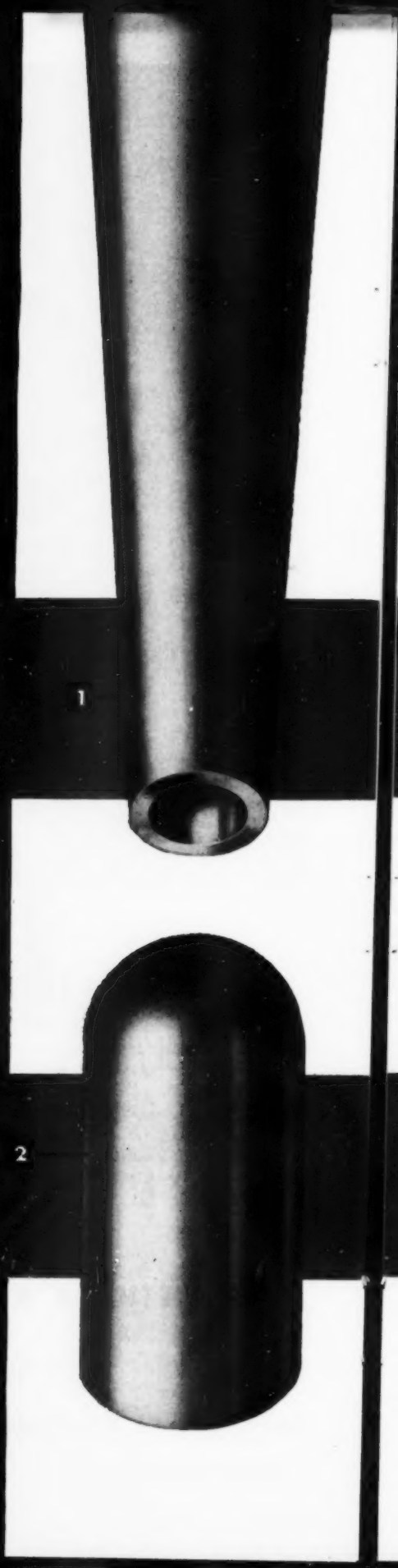
LITTLETON, COLORADO

Contractors to the United States Armed Forces for Rockets, Shells, Fuzes, Research and Development

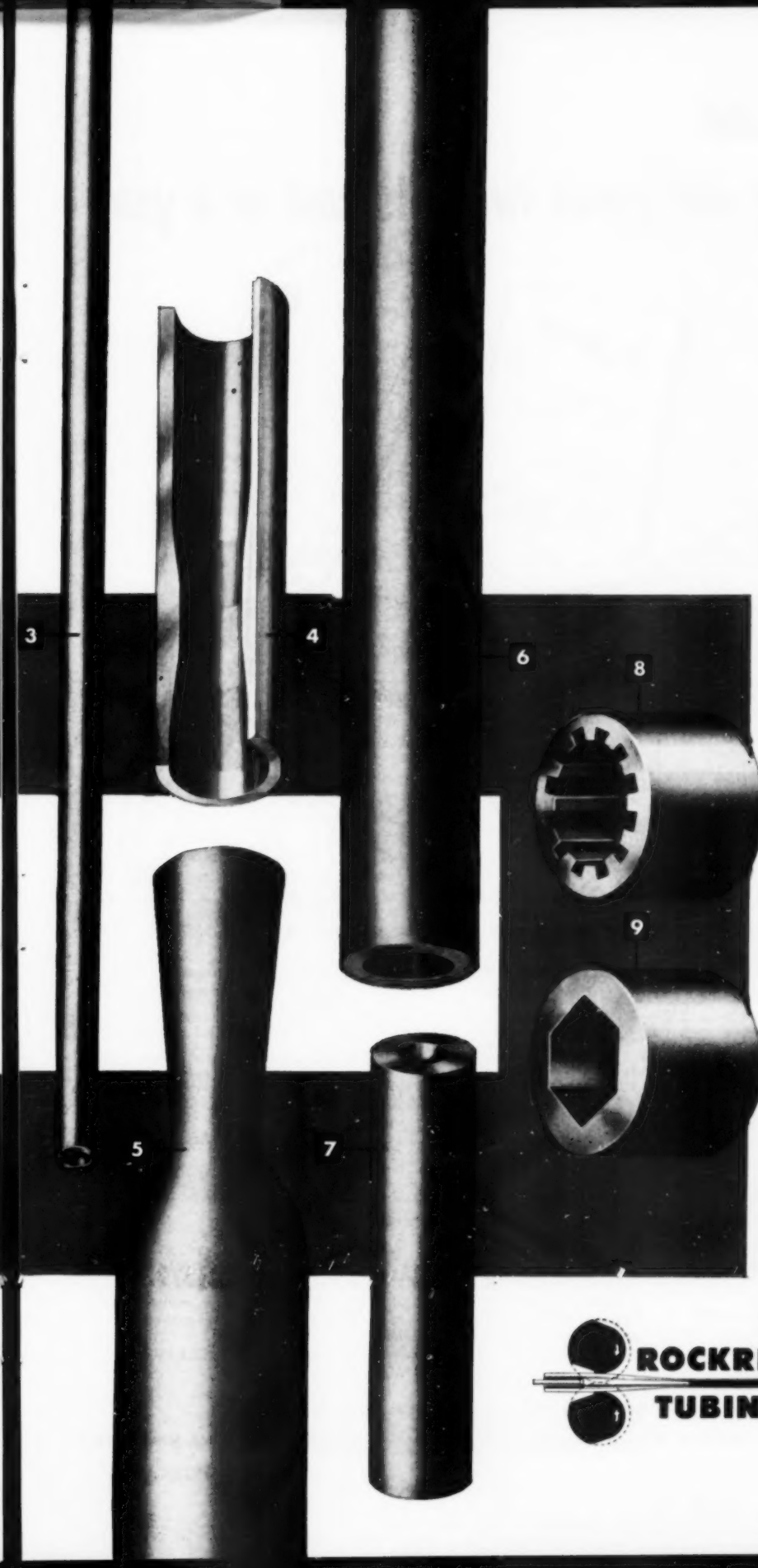
Start right with ROCKRITE®

and cut the cost of parts

The superiority of Rockrite Tubing is due to the method employed to produce it — a distinctive method radically different from the conventional ones used to cold finish tubing. The superiority of the tubes thus produced results in better surface finish, superior machinability and improved mechanical properties. All of which means lower costs to machine or form ring shaped and tubular parts. In some cases costs can be cut in half. So it pays to start right with Rockrite, to make parts that are right—from start to finish. For more information write for Bulletin R2.



Wallington, New Jersey



1. Tapered Tubes. Maximum OD at large end—5½"*. Available with straight taper or stepped, with wall thickness uniform or tapered.

2. Closed End Tubes. Maximum OD 5½"**. Closed by electric-resistance heating and spinning against a suitably formed die. Preserves close tolerances. Produces good finish.

3. Rockdrawn Tubing. OD ¼" to 1½". Lengths up to 65 ft. Quantities as low as 1250 ft. Rockrite close-tolerance tubing, cold drawn to small sizes, in small lots. Ideal for hydraulic lines. Has all three essentials for cold forming.

4. Inside Upset Tubing. Maximum OD 5½"*. Maximum length 65 ft. Maximum taper leading to offset portion, 7 degrees.

5. Flared Nozzle-End Tubes. Maximum OD 5½"**. Surface finish and tolerances much closer than attained by usual hot-forming methods.

6. Cylinder Tubing. OD 2" to 5½"*. Superior inside surface, no scoring, with low RMS rating. Ready to be cut to length and used as is with soft-packing pistons. Permits standardization of hydraulic and pneumatic cylinder parts.

7. Heavy-Wall Tubing. Sizes ⅛" to 5½" OD*. Wall thickness tolerances less than half those of commercial tubing.

8 & 9. Special Bore Tubing. Maximum OD 5½"*. Bore shapes available—square, triangle, hexagonal, gear or spline, and numerous others with very slight radius at corners.

* Maximum OD will be increased to 17" in 1954.

**Maximum OD will be increased to 10" in 1954.

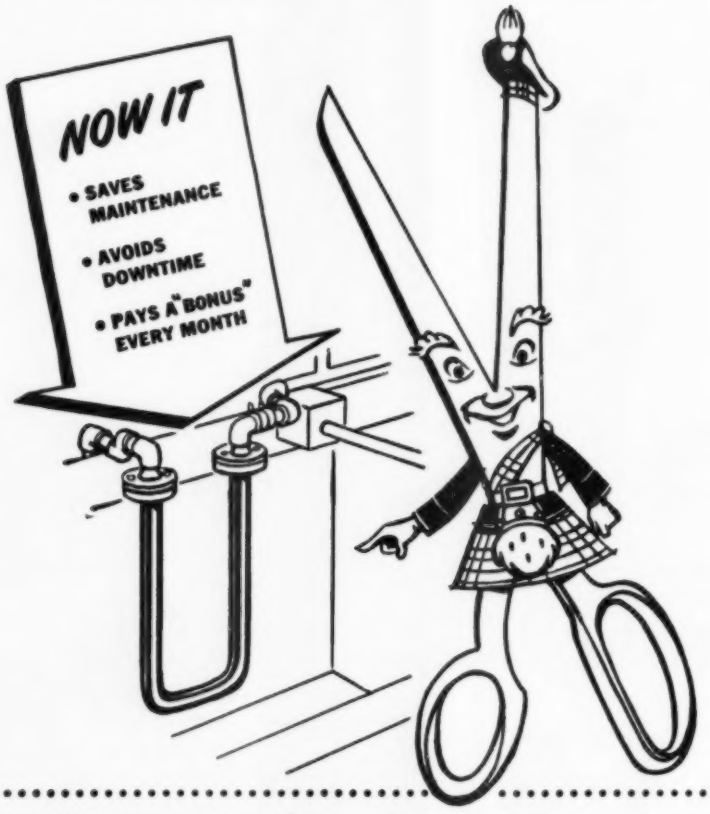
ROCKRITE®
TUBING

Heating coil saves twice its cost in a year

Lead coils were being used by a producer of automobile components to heat "dragout" chromium plating solution in a concentrating tank. Because of severe corrosion, the lead coils were either being repaired or replaced every month. This was costly not only in equipment and labor but even more so in downtime.

As "headquarters" for coatings for metals, United Chromium was asked what could be done. The Unichrome Man urged installing a Unichrome tantalum heating coil (which is more than just acid-resistant – it's acid-proof).

A half year told the story. No more breakdowns. The coil paid for itself in six months. At year's end, savings totalled to almost twice its cost – and the coil is good for years more of such trouble-free service.



MORE WAYS UNITED CHROMIUM HELPS CUT COST OF COATING METALS

No cyanide ...no disposal cost

Problem of waste cyanide disposal is serious one. Containing no cyanide, the versatile Unichrome Copper Plating Solution has enabled companies to save on both disposal equipment and cost of disposal.

Expense of new tanks avoided

A company, needing more capacity to plate increased cutlery production, found that using Unichrome SRHS Chromium Plating Bath speeded up plating output without need for extra equipment.

Maintenance money saved

A plant insulated and coated plating barrels with rubber. When a Unichrome Plastisol Compound was used instead, it not only cost less to apply, but also lasted 2 times longer.

TO FINISH IT BETTER AND SAVE

call in "The Unichrome Man"

UNICHROME

Trade Mark

It pays to consult United Chromium on Metal Finishing Problems

United Chromium offers you the advantages of: (1) 25 years of specialized experience in metal finishing; (2) Wide experience in *both* organic and plated finishes; (3) A diversified line of products for decorative and functional finishing – including plating processes, protective coatings, chemical conversion coatings for zinc; (4) Thinking geared to *cost-cutting, product-improving* possibilities.

We'd welcome an opportunity to help you "Finish it better AND SAVE."

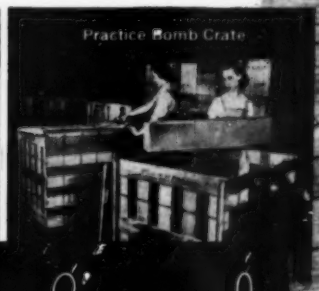
UNITED CHROMIUM, INCORPORATED 100 East 42nd St., New York 17, N. Y.

Waterbury 20, Conn. • Detroit 20, Mich. • Chicago 4, Ill. • Los Angeles 13, Calif. In Canada: United Chromium Limited, Toronto, Ont.

Everyday more and more service shipments go **WIREBOUND**

An ever increasing number of suppliers are taking advantage of improved Military and Federal specifications so that they may obtain the benefits of Wirebound containers for Armed Service shipments. They've found Wirebound box manufacturers well qualified to supply containers that meet government requirements for parts, equipment, over-packs, food and hundreds of other uses. Wirebound plants throughout the country are up-to-date on Armed Service shipping specifications and have the experience, technical know-how and testing facilities to produce the best container for each use. Why not check with your Wirebound supplier or write for full information!

Wirebound Box Manufacturers Association
Room 1163, 327 South LaSalle Street, Chicago 4, Illinois



Wirebound
BOXES & CRATES

75 WIREBOUND BOX PLANTS are ready to serve you!

Engineered to Out-Perform

...and BUILT TO LAST

• CONTINENTAL •

RED SEAL POWER

T-6427 TRANSPORTATION ENGINE.
163 BARE ENGINE HORSEPOWER AT 2600 R.P.M.

For more than 50 years, Continental has been engineering power plants to do more useful work per pound of engine weight, and building them to run longer with less time out for repairs. Materials flow more steadily and at lower ton-mile cost, when they move to the job in trucks with dependable Red Seal power. And the range of the Red Seal line—28 basic models, Diesel and gasoline—assures exactly the right engine for every commercial transport job.

Continental Motors Corporation

MUSKEGON, MICHIGAN

1819 BROADWAY, NEW YORK 23, NEW YORK • 6218 CEDAR SPRINGS ROAD, DALLAS 9, TEXAS • 3817 S. SANTA FE AVE., LOS ANGELES 58, CALIF.

910 S. BOSTON ST., ROOM 1008, TULSA, OKLA. • 1252 OAKLEIGH DRIVE, EAST POINT (ATLANTA) GA.

Phosphatizing steel

CRYSCOAT-HC DOES A FINE JOB COATING 90 MM. SHELLS

This munitions maker says that Oakite CrysCoat HC put a heavy phosphate coating on 385,000 shells with "absolutely no trouble . . . maintenance and control are very easy."

Electrocleaning zinc die castings

No. 95 HAS CUT OUR CLEANING REJECTS BY MORE THAN 90%

Estimates a hardware manufacturer who found other "very fine advantages" in the use of Oakite Composition No. 95 for conditioning zinc-base die castings before plating.

Rust prevention

THIS SAVING HAS BEEN OVER $1,000 A MONTH

Reports appliance manufacturer after 6 months use of Oakite Special Protective Oil for protecting precision steel parts from rusting between machining operations.

Solvent cleaning of steel

WE SAVED $394 LAST MONTH . . . NOT ONE REJECT

Reported a manufacturer who used Oakite Composition No. 8 for cleaning hydraulic cylinders and protecting their machined surfaces from rusting before installation.

Burnishing

STEEL GEAR PLATES LOOK LIKE MIRRORS. O.C.#3 IS HERE TO STAY

This maker of aircraft instrument parts said more about our fine burnishing material: "Pinions are polished to the roots of the gears. Magnesium parts are brilliant."

We help our customers write success stories

Every day 200 Oakite Technical Service Representatives use Oakite cleaning materials and Oakite methods to help thousands of Oakite customers accomplish metal-cleaning jobs that are important parts of big production operations.

When a busy customer sends a few words of appreciation—like those quoted on this page—we look on his words as a *success sentence* that we have helped him write in his *success story*. And we feel proud of our co-authorship.

How about your success story? If you will mail the coupon, we'll be glad to tell you how we can help.

SPECIALIZED INDUSTRIAL CLEANING
OAKITE
MATERIALS • METHODS • SERVICE

Technical Service Representatives Located in Principal Cities of United States and Canada

OAKITE PRODUCTS, INC., 14F Rector St., New York 6, N. Y.

Tell me about Oakite methods for the indicated jobs:

- ☐ Tank cleaning
- ☐ Machine cleaning
- ☐ Electrocleaning steel
- ☐ Electrocleaning non-ferrous materials
- ☐ Pickling, deoxidizing
- ☐ Pre-paint treatment
- ☐ Paint stripping
- ☐ Steam-detergent cleaning
- ☐ Barrel cleaning
- ☐ Burnishing
- ☐ Rust prevention
- ☐ Treating water in paint spray booths

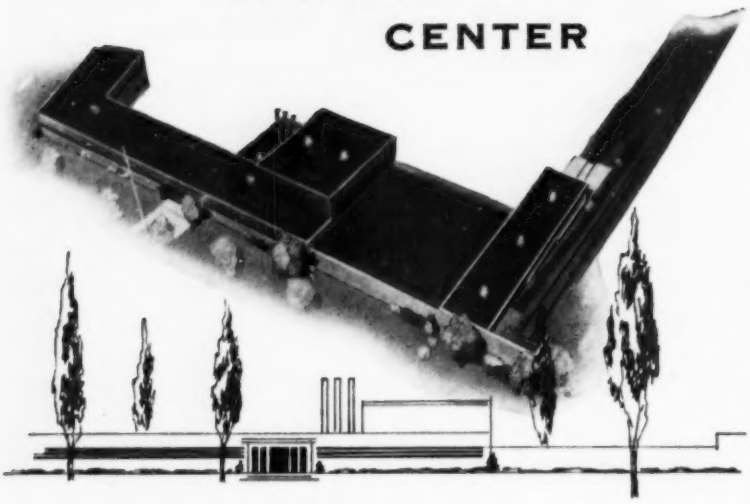
☐ ALSO send me a FREE copy of your booklet *"Some good things to know about Metal Cleaning."*

*Name*_____

*Company*_____

*Address*_____

NATIONAL
TECHNICAL
CENTER



Building for your future...

Newest physical testing machinery . . . latest electronic test devices . . . a new building designed for their efficient use . . . railroad car impact test tracks—that's the *new* National Technical Center where tests and research on castings will be carried out.

The Technical Center's facilities are available to you manufacturers and railroaders who seek new facts and data on the strength and weakness of castings used in your products.

We invite your inquiry for discussion of possible assistance the National Technical Center can give you. Write for descriptive bulletin on test facilities and equipment.

NATIONAL
MALLEABLE AND STEEL
CASTINGS
COMPANY
Cleveland 6, Ohio

85TH ANNIVERSARY
M&S C
1868 ... 1953

A-8266

ATOMIC ENERGY

NEW ATOMIC MONITOR

The first "packaged" automatic control system to monitor the operation of atomic piles and their related processes electronically has been successfully designed by the Minneapolis-Honeywell Regulator Company.

The system will include a multiplicity of electronic instruments—amplifiers, servoamplifiers, recorders, controllers, and servomotors—which will automatically regulate the rate of power generation of the nuclear reactors at predetermined levels. Essentially this is done by automatically regulating the reactor's control rods, which are analogous to an automobile's throttle.

The new system provides robotlike safeguards against dangerous operating conditions. The new reactor control system will be especially valuable when linked to other automatic equipment to make feasible the conversion of nuclear energy into electrical power by private industry.

The initial function of the new reactor control system is to guarantee a "safe start-up" of the chain reaction. This reaction commences when the nucleus of a uranium atom is split under neutron bombardment. As it splits it releases more neutrons. These, in turn, split additional nuclei, releasing more neutrons, thus producing a chain reaction. To sustain this reaction a specified number of neutrons must be liberated each second.

As the control rods are removed to begin this chain reaction, a neutron-sensitive detector in the reactor itself sends out tiny "pulses." These are picked up by an electronic amplifier—one pulse for each neutron detected by the chamber. Another electronic device counts these pulses, totaling them on a digital register.

The operator, by determining the number of pulses occurring each second (or any given period of time) knows the rate at which the reaction is increasing and adjusts the control rods accordingly.

As the reaction increases, still another electronic instrument, a counting rate meter, integrates these pulses, translating them into voltage readings proportional to the number of pulses detected per second. The over-all effect is to provide the operator with an automatic means of sensitively regulating the early stages of the chain reaction.

During this entire start-up process, and after the proper operating level has been reached, other electronic units in the control system are continually monitoring the reaction. For example, one series of

is CORROSION RESISTANCE

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BIGGEST SYNCHROTON

Europe's biggest proton synchroton—the second largest in the world—is now in test operation at Birmingham University, England, according to a recent statement by Professor of Physics P. B. Moon who has been in charge of the team of about twelve physicists and engineers engaged in building the machine for the past seven years.

It is hoped that the machine, which has a magnet weighing 1,000 tons and measuring 32 feet in diameter, will speed up protons to about 90 per cent of the velocity of light, giving them an energy of about 1,000 million volts, compared with the 10 million volts achieved by the university's existing cyclotron. Energies achieved in operation already amount to 250,000,000 volts.

The machine will be used for research in nuclear physics, particularly for reproducing in the laboratory some of the processes of cosmic radiation. Researches are in the field of pure science and have no connection with the atomic bomb.

Cost of construction of the synchroton was around $700,000, most of it provided from Britain's Department of Scientific and Industrial Research.

COLLEGE REACTOR

The North Carolina State College of the University of North Carolina and the Atomic Energy Commission have signed an agreement which opens the way for immediate operation of the first university-owned nuclear reactor in the Nation.

Through the contract the AEC will loan North Carolina State College enough fissionable uranium 235 to fuel the college's "Raleigh Research Reactor," recently constructed in a new building on the campus.

Provision of the fissionable material, or fuel, for the new reactor culminates a project which has been under way since June 1950 when the college, under con-

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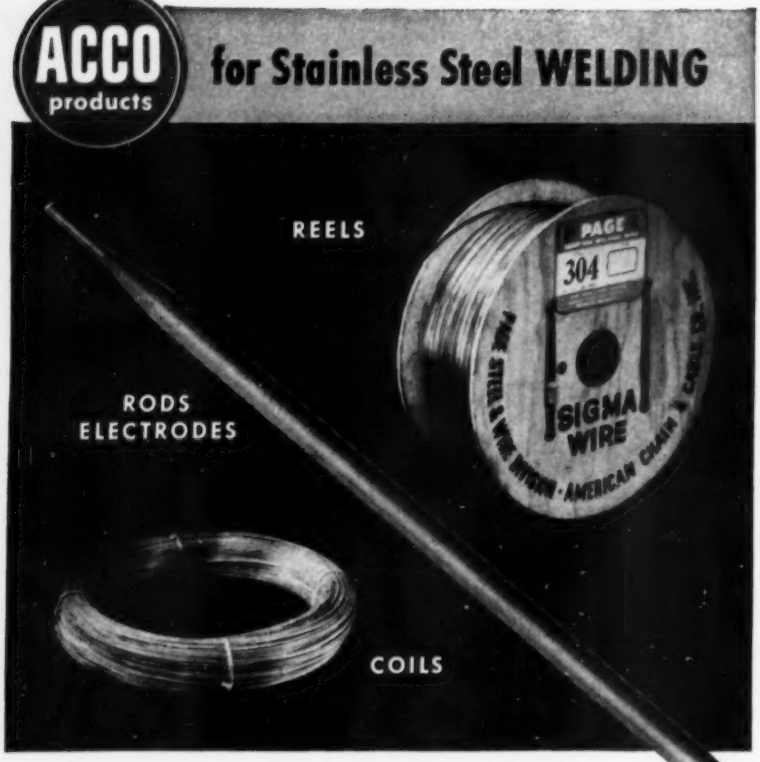

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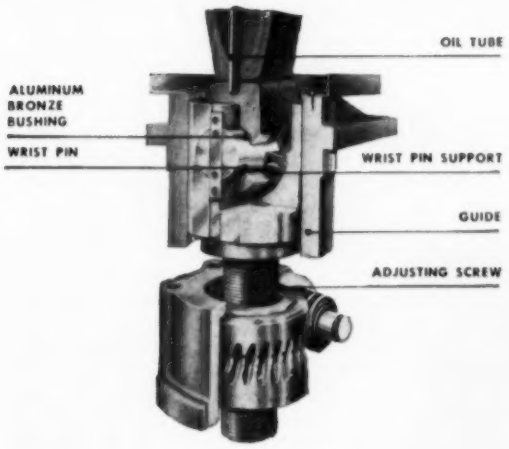

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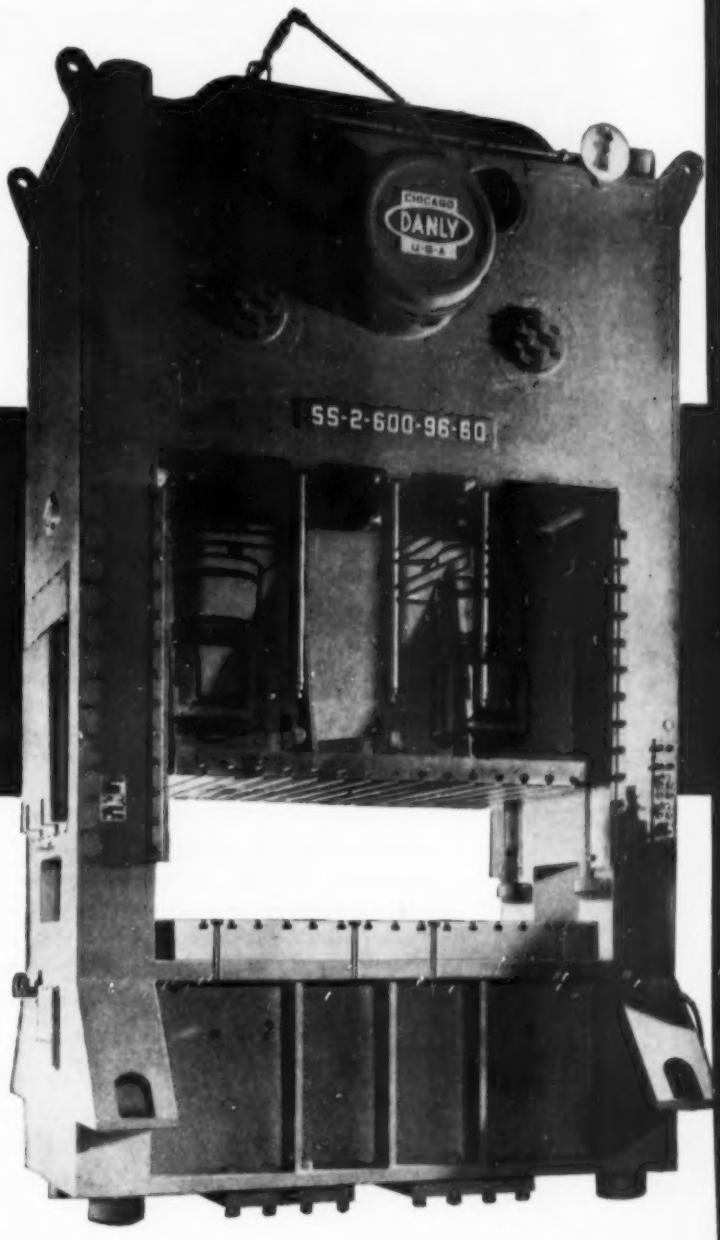

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tract to the AEC, initiated design and construction of a low-powered research reactor.

The building to house the reactor was completed at Raleigh in May 1953, with construction and assembly of the reactor's components finished since that time. The reactor assembly is now complete, and most of the preoperational testing also has been completed. Loading of the fuel and initial operation of the reactor will begin as soon as the fissionable material is received from the AEC.

The reactor was designed and built completely with university funds available to the college and consequently is owned by the institution.

One of its major purposes will be to supply reactor experience to undergraduate and graduate students in nuclear engineering, a new curriculum initiated by the college in 1950. During the coming academic year the college expects about 120 students to enroll in nuclear engineering. There were 110 students in this curriculum last year.

A program of research on the reactor itself is scheduled for the first year of its operation, after which the emphasis will shift to the use of radiations and radioactive isotopes produced by the reactor in numerous research activities of the college and neighboring institutions.

The reactor project is under the technical direction of Dr. Clifford K. Beck, who is also head of the college's physics department. Dr. Beck was associated with the atomic-energy program from 1942 until 1949 when he accepted his present post.

North Carolina State was the first educational institution to approach the Commission with a proposal to design, build, and operate a research reactor, and its proposal was the first one approved by the agency. Since that time, several other institutions have proposed similar projects which are under consideration.

In making the fissionable material available to the college on loan, the Commission acted under the Atomic Energy Act of 1946, which permits the distribution of such materials for research and development activities and for medical therapy.

Before approving the loan, the Commission assured itself that the reactor would be used in a well-planned research program. In operating the reactor, the college must also comply with certain health, safety, and security requirements established by the Commission.

The loan agreement will extend until June 30, 1954, and thereafter will be extended automatically on June 30th for an additional year, unless one of the parties notifies the other, before April 1st of any year, that it wishes to terminate the contract on the next June 30th.

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One of Roy Kohl's five scrapers hauling a 24-yard load at Lockbourne Air Force Base. On this 212,000-yard job, the scrapers load in 90 seconds and travel to the spreading site at 30 mph.

In 1949, Roy Kohl was a basement excavating contractor in Ohio. During the last four years he has changed his operation and has moved more than 2½ million yards of ore, earth and clay on many types of big jobs.

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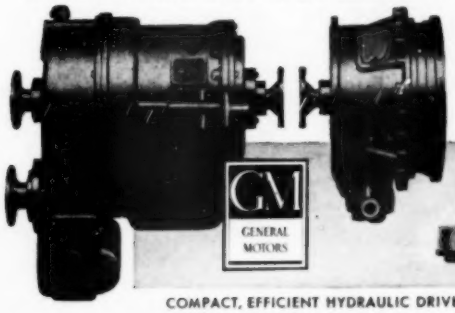

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7

Weapons Research

The Demands Are Great in Peace As Well As in War

HOW big a military research and development program is it wise for our country to have?

There are fringe aspects and basic aspects of this vital problem. The former are widely publicized while the latter tend to be overlooked.

In the fringe or peripheral category are such questions as how the several new Assistant Secretaries of Defense are going to fit into the defense picture and whether it will be possible to weld them into an effective team, not only on the Department of Defense level but, more particularly, in their relationships with the military departments.

It will take time to work out satisfactory answers to these questions, but the good will and common purpose of all concerned assure eventual success. It is tremendously heartening to know that there are already in the defense program so many very fine and very competent people who have a determination to make the system produce.

The Main Problem

But these are fringe considerations. When we dig into the main problem regarding the proper size of our military research and development program, in peace and in war, and in terms of maximum security at the lowest possible cost to American taxpayers, we find that the main problem immediately breaks down into questions about technical manpower, the budget, approval of planned obligations, and similar matters.

Donald A. Quarles, whose photograph appears on the front cover of this issue, was formerly vice-president of the Western Electric Company and president of the Sandia Corporation. He became Assistant Secretary of Defense for Research and Development on September 1, 1953.

Mr. Quarles was associated with the Western Electric Company and the Bell Telephone Laboratories in New York City in various capacities from 1919 until he entered the Department of Defense.

In recent years Mr. Quarles has been actively associated with research and development problems in the military establishment. He served as a member of the Committee on Electronics since it was established in August 1946 under the Joint Research and Development Board. He has served as chairman of the committee since January 1949.

Mr. Quarles was born in Van Buren, Ark., in 1894. Shortly after his graduation from Yale he enlisted in the Army and, after two years in France and Germany, was discharged with the rank of captain of field artillery.

Returning to civilian life in 1919, he became affiliated with the Western Electric Company and was assigned to transmission engineering research. Prior to World War II he was in charge of the development of telephone systems. During the war, Secretary Quarles' efforts were largely concentrated on military electronic systems, particularly radar.

Mr. Quarles was formerly chairman of the American Ordnance Association's Electronics Committee.

The second large area of investigation centers around this question: How can the Department of Defense obtain maximum results from the budget level that Congress is willing to support?

This, in turn, breaks down into questions about the part of the work that will be carried out by the military departments and the part that will be done by the Department of Defense; how much should be performed in shop and how much contracted out; and of the latter, how much to nonprofit institutions and how much to industry.

The new Assistant Secretary of Defense for Research and Development, Donald A. Quarles, has given much thought to the pivotal issues and has arrived at certain fundamental decisions that are intended to serve as guide lines for present and future action.

Three Major Conclusions

Here are Mr. Quarles' three major conclusions:

1. We must pursue the most imaginative and aggressive research and development program that we can devise within budgetary limits.

2. In so far as possible, responsibility for their respective research and development programs should rest with the military departments and, in turn, with their highly competent matériel bureaus and services.

However, over-all coördination is required, first, to make sure that the available dollars are wisely spread among all the claimants (and there is always more research and development work crying to be done than can wisely be undertaken) and, further, to see that the programs of the services are properly coördinated and free of unsound duplication.

3. A third fundamental is that we must base military technology on as broad a foundation as possible. We must not only contract a large part of it out to industrial and scientific organizations but must bring into the planning of the program the best scientific and technical talent in the country.

Mr. Quarles will receive the wholehearted endorsement and support of the American Ordnance Association in his practical and realistic program.

"EASY DOES IT" *is the watchword as the Marines' new powerful lightweight truck, the Mighty Mite, is transported easily by helicopter during recent demonstrations (Marine Corps photo).*

Belloc—Military Historian

A Final Tribute to a Great Writer and Scholar

Hoffman Nickerson

HILAIRE BELLOC who died in July of this year not long before what would have been his eighty-third birthday was a good friend to the American Ordnance Association. During his last visit to this country in 1937 he spoke before our annual meeting, and he also contributed several articles to ORDNANCE.

It is also to be remembered that when here he wisely cautioned America to "keep out of the European mess"—advice which, if followed, would at least have saved Europe from the Communist menace which has overhung that continent since 1945.

A devout Roman Catholic and a tireless defender of his Church and of the great traditions of Western Civilization, he was a clear, vigorous, and amazingly productive writer who published at least 138 books in just over 40 years, not to speak of a mass of pamphlets and articles.

Subjects Varied

His subjects were varied, for he wrote travel books, books on general history, biographies, literary criticism, economic and political theory, satires, children's books, studies of roads and road making, fiction, and religion. He also wrote distinguished verse.

About ten per cent of his prose titles are chiefly or exclusively concerned with military history, and considerable parts of many others deal with the same theme. For instance, his "Marie Antoinette" includes vivid sketches of the Saratoga and Yorktown campaigns and an account of the decisive battle of Wattignies which was fought on the day of the unhappy queen's death; fifteen of the many vivid sketches which compose his "Eyewitness" are concerned either with armed combat or with military planning, and so are eleven of the similar sketches in his

"Miniatures of French History."

His love for soldiers and his military interests were lifelong. In his youth he served for a year as a conscript in a French artillery unit—for he had been born in France because of what he was fond of describing as an error in timing on the part of his mother!—and his last published work was a series of articles on the opening phases of World War II.

Political Objective

To show his firm grasp of the relation between war and policy, we may quote from the first chapter of his "Blenheim," entitled "The Political Objective":

"The proper understanding of a battle and of its historical significance is only possible in connection with the campaign of which it forms a part; and the campaign can only be understood when we know the political object which it was designed to serve.

"A battle is no more than an incident in a campaign. However decisive in its immediate result upon the field, its value to the general conducting it depends on its effect upon the whole of his operations; that is, upon the campaign in which he is engaged.

"A campaign, again, is but the armed effort of one society to impose its will in some particular upon another society. Every such effort must have a definite political object. If this object is served the campaign is successful. If it is not served the campaign is a failure. Many a campaign which began or even concluded with a decisive action in favor of one of the two belligerents has failed because, in the result, the political object which the victory was attempting was not reached."

A few pages further on he concludes: "In connection with the general struggle against Louis, that campaign [of Blenheim] formed the turning point between the flow and the ebb in the stream of military power which Louis XIV commanded and had set in motion.

"From the day of Blenheim, August 13, 1704, onwards, the whole French effort was for seven years a desperate losing game, which, if its end was saved from disaster by the high statesmanship of the king and the devotion of his people, was none the less the ruin of that ambitious policy which had coincided with the great days of Versailles."

The high quality of these quotations needs no comment. One is tempted to say, in a phrase of Boswell's Dr. Johnson: "Sir, it cannot be better done."

In the matter of tactics, at the opposite end of the military scale from the political background or framework of war, Belloc had an amazing knowledge of terrain. His principle was: never write about a battle until you have walked over the ground at the time of year when the action was fought, and he followed that rigid rule more thoroughly than most of us follow any difficult precept on this sinful earth.

Indeed, he not only knew his battlefields; he also knew the theaters of war about which he wrote with an intimacy possible only to one who was a continual traveler and in youth and middle age a tireless walker. Every one who has worked at military history will appreciate the advantage which this gave him over geographically careless or ignorant writers like, for instance, Professor Oman.

In his study of the campaign of Crécy he rediscovered the long-forgotten ford of Blanchetaque by which Edward III and his army were able to escape being pinned against the Somme by the numerically superior French. His account of Poitiers is illuminated by his knowledge of how the grapestakes of neighboring vineyards to this day would be serious military obstacles.

Hoffman Nickerson, distinguished American military historian, has been a lifelong student of Hilaire Belloc. In addition, a close friendship existed between them for many years. In this tribute Major Nickerson summarizes the vast abilities of his master and the influence of the latter upon military thinking the world over. Major Nickerson is a frequent contributor to these pages and the author of a series of books, including "Can We Limit War?"

His book on the Crusades is based not only on literary sources but also on a visit to Palestine.

On the field of Ramillies he was the first to note the little fold of land, hardly noticeable from the French position, which permitted Marlborough to decide the action by shifting cavalry from his right to his left unperceived by his enemies until too late to counter the movement. His years of work upon the campaigns of the French Revolution and Napoleon took him from Southern Spain to the neighborhood of Moscow.

Shortly before 1914 he actually walked over Napoleon's whole line of march from the Niemen to Borodino, perhaps to Moscow itself which is only about seventy miles from that battleground, while from Borodino to the Niemen is not far from six times that distance. He knew every sector of the Western Front in World War I with minuteness and accuracy.

Excellent Maps

Still another quality of Belloc's military work is the excellence of his maps and diagrams. Here again he had a clear principle to which he was faithful: make the map show every feature of the terrain mentioned in your text and no other features.

One could point to a few cases of nonobservance of this; for instance there is one in his account of Napoleon's Italian campaign of 1796-1797. But in so great a mass of published work as his, such exceptions are trivial. In general, he observed this rule as strictly as that requiring a personal knowledge of ground.

Every military student will agree, first, as to the importance of having plenty of clear, easily readable maps unencumbered by unnecessary detail and, secondly, as to the high quality of those given by our author. All such students can remember precious time lost either in trying to figure out exactly what this or that movement was when not enough maps are given, or in trying to find the places mentioned in the text when those places are confused by the unnecessary insertion of endless other places which have nothing to do

with the events described in the text.

Belloc, on the contrary, understood that a military map is not intended to show the almost infinite details given in an atlas or an elaborate topographical map and that a mere diagram will often suffice to give military readers what they need to know.

Many Details

The vividness of Belloc's narratives and descriptions needs no argument. Quotations would be superfluous; the reader can hardly take up any of his military books without noting how he makes his scenes live by bringing in details not only of ground but also of weather and the mood of the principals.

Belloc's studies of the War of 1914-1918 were written under the wartime handicap of insufficient data. For instance, during the second half of 1916 in his weekly articles in the English magazine *Land and Water* he repeated and made his own the erroneous belief of the French and British Army Intelligence Departments (for once in agreement!) which error was that shortage of manpower would make it impossible for the Central Powers to man the new Rumanian front.

The German and Austrian manpower shortage was real enough as was proved beyond question after the war, but at the time it was not quite as severe as was believed, and most of Rumania was promptly overrun.

In the nature of things intelligence officers in wartime must always be groping forward through a twilight of ignorance, and we may compare the equally narrow margin of error by which U. S. Military Intelligence misjudged the chances of the German campaign in Russia in 1941.

There was good reason to believe that the Germans would take Moscow, and only the folly of their politicians in mishandling the masses of anti-Communist Russians and an unprecedented early cold snap prevented their doing so.

For our understanding of present-day war, the most important of Belloc's military works are those which treat of the French Revolution and Napoleon.

Let no one imagine for a moment that the great episode which ended at Waterloo nearly a century and a half ago is irrelevant to our own immediate future. On the contrary, the twenty-three years of practically continuous struggle from 1792 to 1815, the first great conscript war in the history of Western civilization, began the historical phase of so-called "total" or "unlimited" conflict which still overshadows us all. Indeed many thinking men, with the evidences of increasing barbarism all about them, have feared that a continuation of Revolutionary-Napoleonic war may bring down Western civilization.

New weapons have destroyed all but the most elementary principles of tactics, and new means of transport and communication have gone far toward doing the same for strategy, but through all the changes of outward appearance and the astonishing advances in physical science the triple essence of that sort of war has remained the same; first, the constantly increasing powers of governments over the governed; secondly, the frequent wielding of those vast powers by illegitimate dictatorships headed by political adventurers contemptuous of traditional morals; and thirdly the intention to crush the hostile community completely and in the shortest possible time.

Invasion of Japan

This third principle of attempting rapid and total victory was never more conspicuously illustrated than by the astounding American proposal for a land invasion of the Japanese home islands. All economists and all naval officers knew that Japan must surrender within measurable time after the establishment of a reasonably close blockade of those home islands, just as England would have to surrender under like circumstances without the slightest necessity for land invasion.

The only reason for the proposed land invasion of Japan was the Napoleonic bent of the mind of General of the Armies George C. Marshall.

That so unnecessary an invasion with its certainty of heavy losses should have been seriously considered is enough to make us say of the Corsican as Shakespeare's Brutus says of Caesar:

O Julius Caesar, thou art mighty yet!
Thy spirit walks abroad and turns our swords
In our own proper entrails.

Accordingly, under all the glamour which still clings to the memory of the Emperor, the chief interest of any comprehensive study of his career is to help us to understand the Napoleonic obsession which has fastened itself upon Western military thought.

A host of Frenchmen, including Jacques Bainville and Admiral Castex and an almost equal number of English-speaking men, including Admiral Mahan, have contributed to the inquiry. Practically all agree that it was Napoleon's decisions to invade Spain and especially to invade Russia that brought him down. But why did he make those two errors, especially the second?

Belloc's contribution to the debate is to be found chiefly in his "1812" and most of all in his "Napoleon." Perhaps he saw both the French Revolution and the Emperor in too rosy a light, but certainly his enthusiasm for both carried him through a mass of detailed research.

At the risk of oversimplification, let us try to give the substance of Napoleon's story. He inherited in the French Revolutionary Army a powerful instrument of land warfare which possessed the high military asset of mobility.

Vivid Pictures

How this came about is discussed in Belloc's little book "The French Revolution," and there are vivid pictures of what took place in his short historical novel "The Girondin."

In the earlier, chaotic period of that army its mobility and its conscript numbers had only just enabled it to hold out against the regularly organized forces of the kings.

When the ebb tide of revolutionary enthusiasm had produced its usual result in dictatorship and when, as Emperor, Napoleon was for the moment

firmly established as ruler of France, conscription enabled him to place still greater numbers at the service of his own remarkable technical military talents. We should also mention his use of massed batteries of field guns.

The result was a series of rapid and crushing victories since rivaled only by the German lightning campaigns of the first two years of World War II. Although Napoleon's admirals met with disaster at the hands of the English Fleet, he himself entered both Vienna and Berlin in triumph. He cut Prussia off from half her territory, came to an agreement with the Czar, and made himself—for the time being—the undisputed master of Central and Western Europe.

Another Factor

On the other hand, he had to reckon with the Central European ruling class which hated him as the heir of the revolution and the exponent of a new social order based upon equality before the law.

Also, as Admiral Castex tells us, although Belloc does not, he found himself forced to keep considerable garrisons in the German states in order to enforce the severe conditions which he had imposed. Meanwhile he continued to wage economic warfare against England, on the whole successfully.

Why then did he invade the territory of his dependent ally, Spain? Belloc, rightly, I believe, rejects Mahan's contention that English sea power "compelled" the Emperor to this blunder. The strong case for sea power is weakened by such an overstatement.

Our author's judgment coincides with that of the French Admiral Castex in holding that the economic strain upon England was greater than that from which the French Empire suffered and would finally have compelled the English aristocracy to make terms had the Corsican been content with his existing boundaries. English sea power and financial power were acute irritants but not compelling forces.

Belloc thinks that Napoleon invaded Spain not so much because of ambition—and therefore, by implication, still less from megalomania—but merely because he wholly misunderstood Spanish national and religious feeling.

"Still another quality of Belloc's military work is the excellence of his maps and diagrams. Here again he had a clear principle to which he was faithful: make the map show every feature of the terrain mentioned in your text and no other features . . . Belloc . . . understood that a military map is not intended to show the almost infinite details given in an atlas or an elaborate topographical map and that a mere diagram will often suffice to give military readers what they need to know."

French inability to subdue Spain encouraged Austria to make another attack, but when the Austrians had again been crushed, this time with much more difficulty than before, there was still no release from military tension.

Napoleon repeated the error he had made with Prussia. He took so much territory from the defeated Hapsburgs that he found it necessary to leave permanent garrisons in order to enforce his arrangements.

France was tiring of conscript war, and in Central Europe even the populace who had at first welcomed the French as liberators were beginning to hate them as alien conquerors and looters at that.

On Belloc's own showing, Napoleon, the man whom our author characterizes in the last paragraph of his "Danton" as wielding "the most splendid of human swords," acted in invading Russia not like a statesman nor even like the master of military calculations which he had originally shown himself to be.

With an army which numbered about half a million effectives at the outset of the campaign, a mass far too large for effective handling by the Emperor's method of personal command unsupported by a general staff of the sort which the elder Moltke afterward invented, he thrust himself forward in the autumn of that year more than five hundred miles into the Czar's immense empire.

Even if he had been able to destroy most of the organized Russian forces opposed to him, which he consistently failed to do, and if his original numbers had remained intact, they would still have been unable to occupy more than a fraction of the vast Russian land.

Trusted His Power

In spite of all this, after a prolonged hesitation which did him honor while it lasted, he pressed on, trusting solely in his power to compel victories in battle which would enable him to dictate terms.

When the Czar refused to make peace after the Corsican's occupation of Moscow, the latter found himself compelled to a retreat in which he lost most of his army and be himself barely escaped capture. After this disaster he fought on stubbornly, but as government after government turned against him it would have taken a miracle to save him and no miracle was vouchsafed.

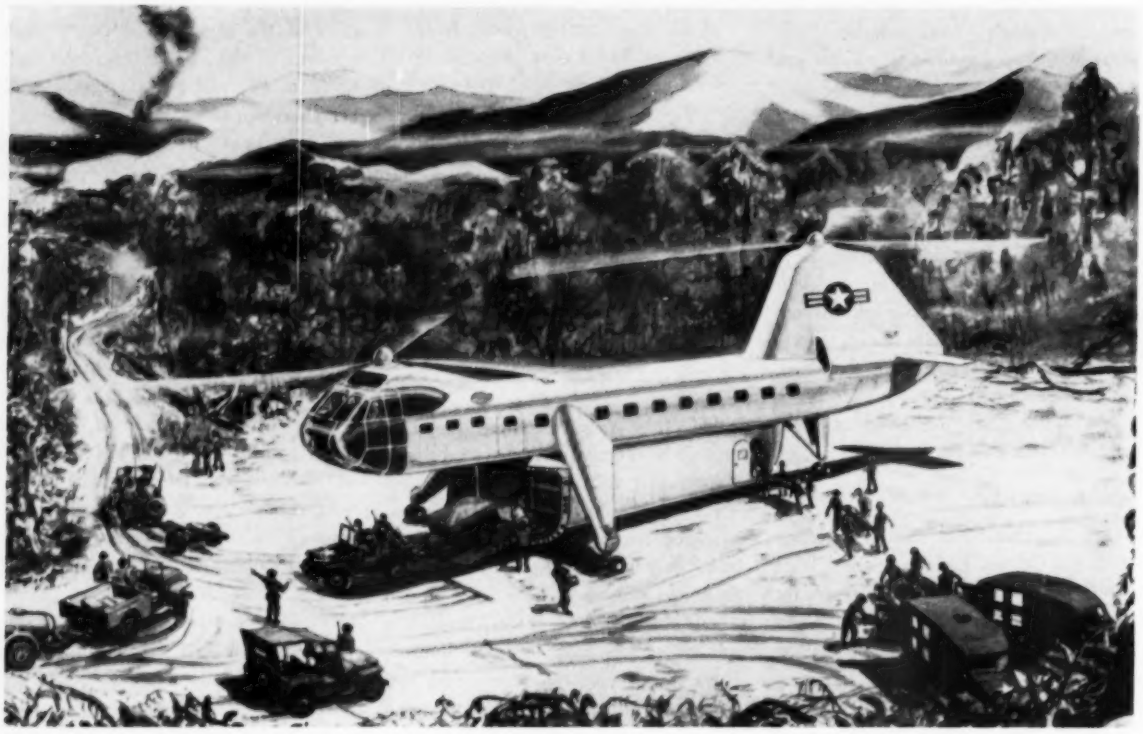
He and the human material at his command had necessarily deteriorated from fatigue, while in a technical military sense his enemies had "learned his game." Belloc's "Waterloo" agrees with the general judgment of history in holding that "even had Napoleon won on that day he would have lost in the long run. The . . . origin of his fall was . . . the decision taken in May 1812 to advance into the vast spaces of Russia."

Gambler or Dictator

In that year, with so much to lose and so comparatively little to gain, that decision was the act of either a determined gambler who cannot resist one more throw of the dice or of a usurping dictator who feels his position at home to be so uncertain that he must go on dazzling his subjects with continual triumphs and cannot safely leave even one strong foreign power unconquered.

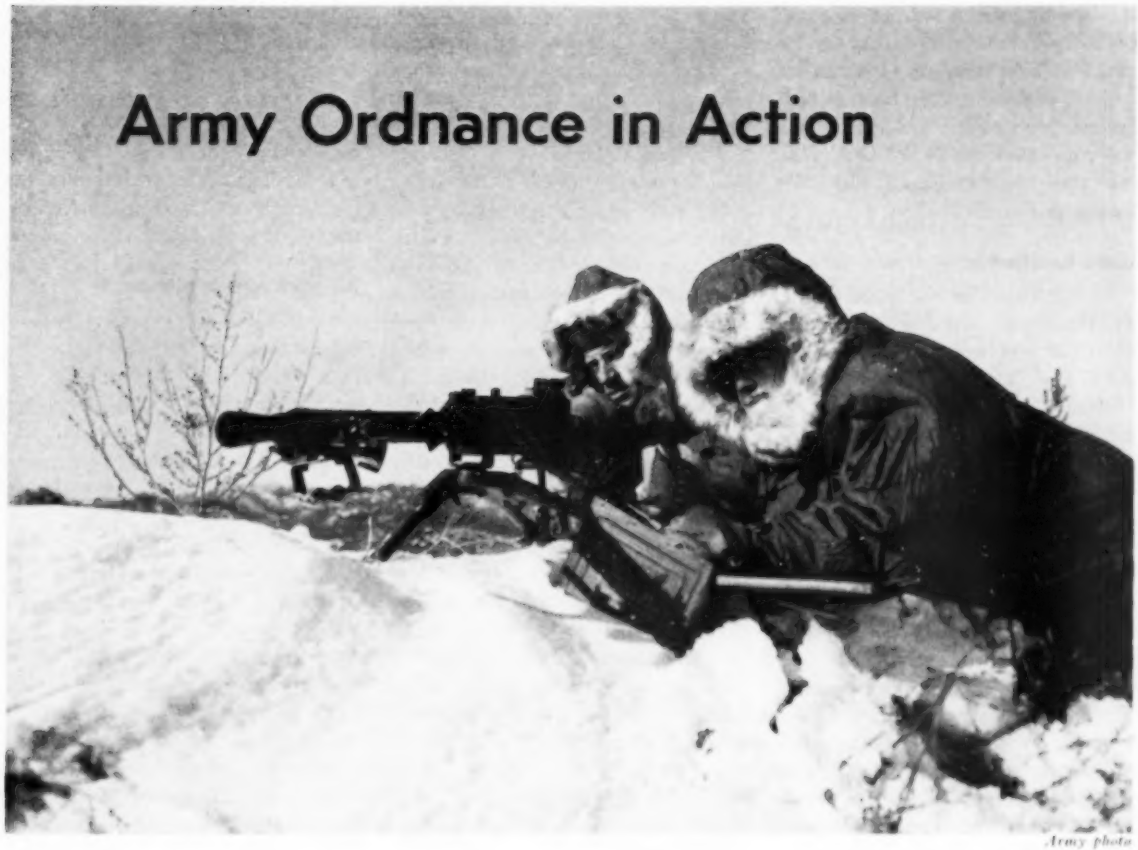
Belloc does not spell out this alternative for us. Perhaps wisely he leaves us to draw our own conclusions from our reading of his exceptionally vigorous work.

Largest Transport Helicopter



One version of the Piasecki YH-16, world's largest transport helicopter, features high landing gear and a removable cargo pod, above. Another version, below, can carry 40 troops, 32 litter patients, or 3 jeeps. With a design gross weight of 30,800 pounds and a fuselage 78 feet long, the YH-16 is powered by two 1,650-h.p. engines and can fly at about 150 m.p.h.

Army Ordnance in Action



Army photo

The Corps Met and Answered the Challenge of Korea

ON November 1, 1949, Maj. Gen. Elbert L. Ford took office as the nineteenth Chief of Ordnance of the U.S. Army. Little did he realize then that he would soon have the responsibility of leading the Ordnance Corps through a so-called "cold war" which had no parallel in this country's history.

Pace Had Slowed

In that fall of 1949 there was everywhere evidence that the Army's rapid pace set during World War II had slowed to a comfortable jog. Procurement certainly was a mere trickle of what it once had been. The machine-tool industry, crux of defense production in time of war, was at a very low ebb. Military planners were still evaluating records of World War II in order to judge future needs while the overburdened taxpayer balked at the thought of a large defense budget.

Ordnance was operating with a skeleton force—3,500 officers as against 24,000 during World War II. Ordnance technicians were salvaging battle-scarred weapons and vehicles from the Pacific and European campaigns and rebuilding them to a "like-new" condition. Significant projects for the development of new equipment continued—new infantry weapons and high-priority guided missiles. Over all there was a trend toward cautious planning for emergency needs in case of war.

In perspective, it now looks as if General Ford's early responsibilities as Chief of Ordnance amounted to a 6-month "honeymoon." For on June 25, 1950, in what seemed like clear and sunny weather, the storm broke over Korea. In a span of weeks, Ordnance was gearing itself to the procurement of mountains of matériel and moving stocks from ninety-seven installations across the Nation.

Critical Years

The three years of fighting that followed were critical for the Ordnance Corps. The problem was how to expand military production and develop weapons without disturbing the civilian economy. It required close coöperation between all of Ordnance and all of industry. Machines and material were the bottleneck, and it was almost a year after the Korean outbreak before Government agencies solved these two problems.

But the story dealing exclusively with Ordnance's own activities is underscored with success. Within the framework of limited mobilization, Ordnance not only provided tools for

the fighting man in sufficient quantity but bounded ahead in its search for new and better weapons. General Ford and his staff went to the heart of both routine and unusual problems, and a few pages from the record book show just how well Ordnance performed during this crucial period.

Units Recalled

At the outset of the Korean war, 83 Ordnance units with a total strength of 11,926 men were recalled to active duty. The Ordnance School and the Ordnance Replacement Training Center at Aberdeen Proving Ground, Md., opened their doors to class after class of officers and enlisted men. New training devices, such as overhead projectors, electronic gadgets, and working-model transparencies were installed to modernize Ordnance's educational techniques.

Numerous programs to develop skills among civilian employees took shape soon after Korea. Notable among these was the Management Engineering Training Program, centered at Rock Island Arsenal, which has trained over 1,700 key officers and civilians. Through improvements in planning, control, and work methods, initiated by these graduates, Ordnance has realized large savings.

More recently, Ordnance has arranged with Toledo University for a series of comptroller training courses which concentrate on such subjects as appropriation accounting, contract pricing, and contract adjustments.

Ordnance's emphasis on controlling and developing its manpower in the past three years has stemmed from one simple fact: it employs nearly 150,000 civilians in hundreds of different kinds of jobs. Mathematician, X-ray technician, engineer, mechanic, ammunition loader—these are a sample of the jobs women also have filled in Ordnance during the Korean period.

It is truly amazing that during these days of intensified and expanded activity, Ordnance improved its safety record. Aberdeen has the hazards of testing new equipment; Jefferson Proving Ground fires over 1.2-million rounds of ammunition annually; 11 plants produce propellants and explosives; 12 plants load and assemble complete rounds; 29 depots constantly receive and ship tons of equipment.

Despite these difficult, often dangerous operations, the accident-frequency rate (number of accidents per million hours worked) in Ordnance installations dropped from 5.3 in 1950 to 2.9 in 1952. Ordnance received the National Safety Council's Award of Honor for Distinguished Service to Safety for both 1951 and 1952.

Greater Supervision

From July 1, 1950, to June 30, 1953, Ordnance had funds totaling $31.4 billion to spend, largely on procurement of matériel. In 1950, General Ford found that certain administrative operations demanded more careful supervision. He did not have the time personally to inspect each of the ninety-seven installations annually. Instead, he established four management field offices in New York, Chicago, San Francisco, and Birmingham.

These offices sent out inspection teams to evaluate the efficiency and economy of operations in Ordnance installations and recommend changes if deficiencies existed. General Ford continually outlined areas in which careful inspection was needed, such as preaward surveys of contractors, Government property in contractor plants, and delinquent contracts.

Ammunition Manufacture

In the 1950 to 1953 period, Ordnance entered into more than 800,000 procurement actions, and of this number 30,000 were in excess of $10,000. Approximately 1,000 prime contractors and 6,000 subcontractors were engaged in the manufacture of ammunition components. Last year alone, contractors turned out more than 52 million rounds of artillery ammunition, 3 billion rounds of small-arms ammunition, 217,000 wheeled vehicles, and 7,000 tracked vehicles.

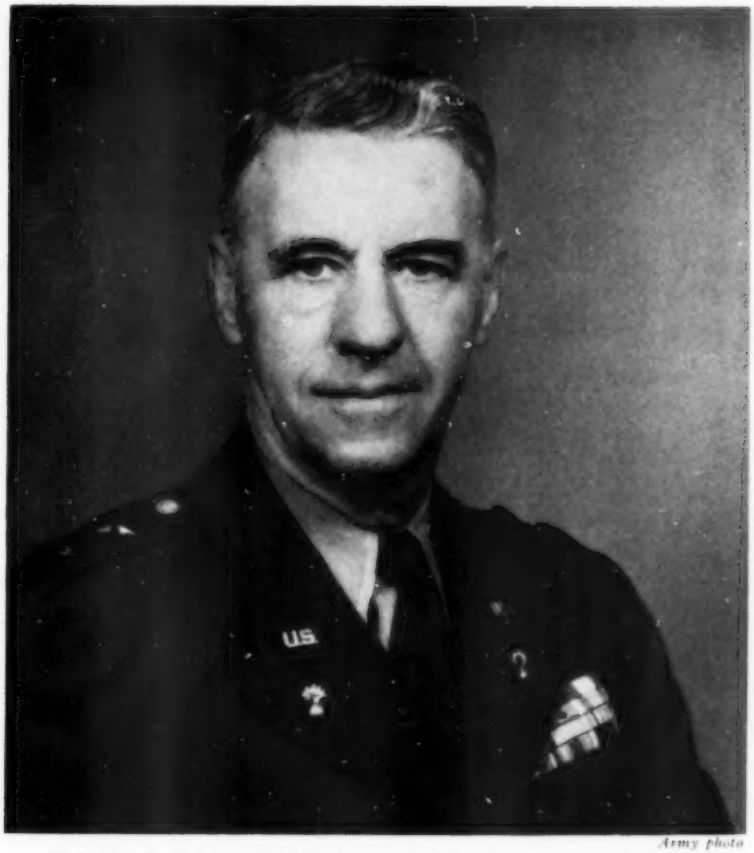
In its procurement planning, Ordnance focused its attention on establishing a broad industrial base capable of rapid expansion to meet any all-out emergency. Ordnance streamlined its procurement by assigning each item of matériel to a field installation, granting more authority to the fourteen district procurement offices, and making maximum use of the three "commodity centers"—the Ordnance Tank-Automotive Center at Detroit, the Ordnance Ammunition Center at Joliet, Ill., and the Ordnance Small Arms Ammunition Center at St. Louis.

Policies Sound

The procurement record definitely proves the soundness of these policies. In 1952 deliveries were more than four times larger than in 1951, and this year deliveries will be more than double those in 1952. Last year Ordnance depots received and shipped 10,463,800 separate items amounting to 6,433,900 tons.

Between July 1, 1950, and July 30, 1953, the Field Service Division restored 1,800,000 tons of ammunition to serviceable condition and shipped more than 2,700,000 tons to the Far East command and 600,000 tons to NATO countries. In this same period, Field Service received 2,900,000 tons of am-

The Ordnance Corps of the United States Army has just passed through one of the most trying periods in its long history. The Korean conflict was a full-scale war, although not officially declared such, so that Ordnance had to operate at wartime speed while under many peacetime restrictions. Despite these handicaps Army Ordnance, teamed up with American science and industry, achieved a magnificent record of production to meet the needs of the Korean campaign. At the same time it had to supply arms and ammunition to our forces at home and our allies abroad. How well it accomplished this task is outlined in these pages, and we wish to pay tribute here to this great record of the Science-Industry-Ordnance Team, led so ably by Maj. Gen. E. L. Ford, who was Chief of Ordnance during the entire period.—THE EDITORS.



Army photo

Maj. Gen. E. L. Ford, Chief of Ordnance, United States Army, 1949-1953.

munition from current production.

To reduce the load of Ordnance paper work, General Ford and his staff assigned back-up reserve depots to key and distribution depots. Today Ordnance, assisted by Sears, Roebuck & Company and RCA, is developing an electronics system for stock control. Consider that there are 525 major and 325,000 secondary items for which Ordnance is responsible and one can see how simplification of stock control brings large savings in time and money.

Rebuild Program

Before Korea, Ordnance in its "rebuild" program had recovered 140,000 tons of spare parts and supplies from the Pacific theater and made 85 per cent of these ready for reissue to troops. Cost of processing the matériel for reissue was about $16 a ton or one-half the cost of shipping one ton of new equipment from San Francisco to Japan.

When Korea came, the rebuild operation in Japan went on a round-the-clock basis and during the first month processed 4,250 vehicles. In Germany, the Karlsfeld Ordnance Depot saves the American taxpayer millions of dollars annually in its massive rebuild operations.

Ideas to Blueprints

While Ordnance was supplying matériel to troops in the field, scientists and engineers were translating ideas into blueprints and blueprints into specifications. Last year Ordnance was engaged in 600 separate projects for the development of over 2,500 items of equipment and components.

Many of the weapons and vehicles used in Korea were World War II models. They were perfectly adequate for the job to be done, and front-line soldiers in Korea considered them rugged, reliable, and effective.

Most spectacular of the new weapons is the 280-mm. artillery gun which can fire both conventional high-explosive and atomic shells at targets 20 miles distant with pin-point accuracy. Six prime contractors, many times that number of subcontractors, five arsenals, and one proving ground worked together to produce this mighty weapon.

Guided Missiles

Two guided missiles, one of them called the Nike (after the Greek goddess of victory), were in factory production in 1952. The Nike missile, controlled from the ground, detonates when close to target aircraft. Ordnance's efforts toward the development of both surface-to-surface and surface-to-air missiles have advanced so quickly that missile antiaircraft battalions are being formed.

Ordnance has begun production of the 75-mm. antiaircraft gun, called the Skysweeper, which can fire 45 rounds a minute—virtually an "artillery machine gun." It is loaded and aimed automatically, and the radar and computer which seek out the target's position are fully integrated with the gun.

The M41 light tank, the Walker Bulldog, weighs 25 tons and mounts a high-velocity 76-mm. gun. The M48 medium tanks mount 90-mm. guns, and the caliber .50 machine gun can be loaded and fired from inside without opening the turret. The heavy member of the family is the T43 tank which mounts a 120-mm. gun and weighs approximately sixty tons.

Over the past few years ammunition researchers have concentrated on proximity fuzes, shaped charges, and high-velocity projectiles, and improvements along these lines have boosted the firepower of artillery and tanks. Tank-killing mines, more lethal than any seen in World War II, have been developed.

Unique Operations

These large operations of training, procurement, production, distribution, and research which General Ford directed as Chief of Ordnance never quite approached the scale of World War II. But in a very real sense, these "cold war" operations were unique in our country's history, and again in this strange crisis Ordnance rose to the occasion and performed magnificently.

Two Recent Ordnance Vehicles

The amphibious carrier, above, known as the Otter, was recently developed by Army Ordnance for use in any climate. On land it can carry a 2-man crew and a number of fully equipped troops at 30 miles an hour. The new M75 personnel carrier, below, earned its nickname of "Lifesaver" in Korea where it rescued trapped 7th Division troops under fire without a single casualty.

Management engineering trainee conducts job analysis at Rock Island Arsenal.

Management Engineering

Ordnance Trains Key Employees To Solve Specialist Shortage

Col. R. E. Peters

WHEN, shortly after the outbreak of hostilities in Korea, the Army Ordnance Corps had to double, then triple its military and civilian work force and multiply its production of military matériel a hundredfold, it paid more than lip service to the spreading concepts of modern industrial management.

High Priority Given

Placing the same high priority on management men as had already been placed on scientists and engineers, Ordnance set up a Management Engineering Training Program and implemented it with a school located at Rock Island Arsenal, Rock Island, Ill., and followed through its scheme of action so that by July of this year it could count 1,500 alumni of its school, representing 90 of 97 Ordnance installations nationwide.

Management schools for promising white-collar workers and junior executives have long been an integral part of many large corporations. Schools for men with managerial capacities have been considered as essential as schools for machinists.

General Motors, Ford, Du Pont, General Electric, and similar corporations have run permanent or semi-permanent schools for years on the principle that executive ability is the product of extensive training as well as the gift of natural talent.

Demand Exceeds Supply

In the past decade, the demand for trained management men has more than overdrawn the supply. Corporations have found that to keep pace with growing size and more complex operations, they must assiduously ferret out and train men who possess an unusual aptitude for managing large-scale manufacturing processes. Indeed, they corral graduates fresh out of the country's many industrial management schools, but additional training is forever necessary.

Ordnance's school is an offshoot of this mushrooming movement. It is just another manifestation of a tested idea.

Revolutionary

But in other respects, the school is revolutionary. Though financed and operated by Ordnance, it is devoid of the multifarious regulations and rules that often strait-jacket a military school. Likewise, though situated on arsenal grounds, it is in every way a tiny college smacking of the free exchange of ideas usually associated with a university campus.

Its staff, most of whom carry graduate degrees in industrial engineering and related subjects along with experience in industry, is primed with the latest ideas on management techniques, and if some of the written material used in class suggests the dryness of a training manual, the resemblance is purely accidental.

Full-Fledged Experiment

Ordnance's school is the first full-fledged experiment in developing management men ever attempted within the military establishment. Various branches of the Government and the military services have tried, at times, to apply to their organizations the advanced techniques of management which companies and universities have uncovered over the past decades.

Generally speaking, these attempts have been either piecemeal or plain unsuccessful. In the military sphere, fresh management ideas have been hide-

Colonel Peters has served as executive officer in the Office of Manpower, Office of the Chief of Ordnance, Washington, D. C. He is now attending the Army War College at Carlisle, Pa.

bound by the "command function" which tends to force rather than persuade a man to do something, which, in its worst form, bosses rather than leads.

And, until recently, the law of the land has provided hidden obstacles. Since World War I, Congress had tagged annual appropriation bills with riders prohibiting the use of refined, up-to-date industrial engineering techniques in managing Government agencies or installations.

Ban Lifted

Then in 1949 Congress, evidently realizing that the introduction of scientific management would not only increase output but would also improve employee conditions, lifted the ban. The follow-up was Executive Order 10072 from President Truman which requested an accelerated pace of management improvement in Government agencies.

It is perhaps logical that Ordnance made the first definitive step. A commanding officer in a combat zone must give orders and expect them to be obeyed; in the immediate execution of his command decisions rests the possibility of saving hundreds, perhaps even thousands of precious lives.

But a commanding officer in an arsenal, procurement center, depot, or plant operates in an entirely different climate. His worries are economy of manufacture, efficiency of office work, and coöperation of employees. His problem of directing a group of men is not the exercise of control such as he must use in combat; instead, he has the responsibility for getting the most out of a freewheeling group of men and women, the majority of whom are civilians.

The commanding officer, his staff, his supervisors, and the mass of employees under him are, of course, under Government regulations. The installation is military, as it should be, and requests, directives, regulations, and orders coming from the Office of the Chief of Ordnance command a disciplined response.

But strip an Ordnance installation of its military paraphernalia—the officers' blouses, the military titles, the special stock numbering, the occasional olive-drab paint job, and all those trappings which are peculiar to the military—and basically it is the duplicate of private industry. The structure and aims are almost the same.

An Ordnance arsenal, for example, designs, engineers, builds, and distributes a product or many products. The human-relations problems that arise in these phases of manufacture parallel those in industry. The commanding officer, civilian chief, works manager, branch chief, and chief engineer must be as adept and as versatile as a top-flight industrial staff.

Shop work, materials handling, accounting procedures, and many other facets are also common to both Ordnance and industry. The comparison is weak in spots, for Ordnance fulfills a mission while industry seeks a fair profit; Ordnance produces mostly pilot lots while industry makes what the market will absorb, and so on. But of all military activities, Ordnance best characterizes industry in uniform, the civilian-soldier on a Paul Bunyan scale.

Awaited Cue

This is the broad setting in which to view Ordnance's exploratory interest in management. With these general considerations alive, Ordnance awaited the cue for action.

The outbreak in Korea signaled an opportunity for management improvement. Loaded with the responsibility for quickly producing weapons and matériel, Maj. Gen. E. L. Ford, Chief of Ordnance, took inventory of his organization's resources. The urgent problem was manpower.

What General Ford had was efficient but small. In the rush of production he would have to increase his work force from 60,000 civilians to about 170,000. Ordnance would be severely handicapped by the relative inexperience of these additional tens of thousands.

Fully aware of the need for mechanics, engineers, contract negotiators, scientists, and other specialists, General Ford nevertheless pictured the problem as an over-all task of management.

Soon after President Truman's order appeared, General Ford had set up management offices in all major installations. Though performing useful functions, such as analyzing manpower requirements, these offices tended to retrace old rather than break new paths.

What General Ford wanted, apart from offices, was the development of new attitudes toward management problems—in a sense, a management psychology which, while operating in conformance with rules and regulations, would sanction any approach to the solution of a problem as long as it proved useful.

The final satisfactory approach might flow from accredited ideas developed in universities or from the free exchange of ideas among Ordnance personnel or from a continuous reëxamination of the operational structure of an installation. The solution for a problem would be tried before the jury of economy and efficiency and judged either useful or useless.

To this end General Ford appointed in October of 1951 a choice committee of five civilians—Dr. Philip Hensel of Toledo University, Dr. Russell Moberly of the University of Wisconsin, Dr. Marvin E. Mundel of Purdue University, Berger Stockfleth of Pacific Engineers, and Lee Osborne of the Wassell Corporation.

This committee, pooling its academic and industrial knowledge and consulting with representatives of Ordnance's Civilian Personnel and Training Office, assembled, digested, and simplified quantities of information presented to it.

Definition Given

As a starting point the committee crystallized its thinking into a hard definition of management: "Management designs, predicts the performance of, and controls an integrated group activity, the related physical facilities, and the interrelationship of the two."

The committee determined that by its very nature management lacks rigidity and that its operational character works in a dynamic pattern

where planning leads to activity and activity, in turn, feeds back new information to the planner. In sequence, management sets the aim, gathers data, makes a decision, and implements the decision with tools, techniques, and training.

Changing Relationships

But, as indicated in the definition, the end results of management can only be thought of in terms of continuously changing relationships which prompt new decisions. The feedback principle is circular, flexible, and shifting.

The committee next isolated the problem areas in its definition and pinpointed the data and design areas as the most crucial. Complete, understandable data precede sound decisions, and sound decisions demand careful evaluation. From this the committee decided that, to carry through a program of management improvement, Ordnance had to teach as many key employees as possible the techniques for gathering data and making decisions.

Three Choices

Finally the committee offered three courses of action: management consultants, traveling teams, and direct schooling. The first two were scratched as unrealistic. Consultants would face the insurmountable task of absorbing in a short time quantities of information, specialized nomenclature, and the peculiarities of a monolithic organization. The consultants would also have to cope with the reluctant welcomes which installations might proffer to "snooping" outsiders.

Traveling teams of management experts, incorporated fully into the Ordnance organization as working members, would have an easier time of it, but even if the team steam-rolled through one installation each week, it would take over two years (allowances for vacations and sickness included) to complete the circuit through Ordnance's ninety-seven installations.

The establishment of a school, the committee concluded, showed the greatest promise. It would be simpler to bring management techniques into Ordnance than to try to package Ordnance's problems and methods in a dossier for a management consultant to examine. A school would better match theory to practice—in other words, apply management techniques to urgent Ordnance problems.

Members of a class in production planning and control listen to fellow student discuss a production control device as part of the management engineering program.

Employees pulled from all parts of the country would learn merely from personal contacts and conversations. And beyond this, students at such a school would improve letter and telephone communication between installations by seeing how their function at installation A fitted in with a related or seemingly unrelated function at installation B.

All pros and cons resolved, the committee recommended a school, and Rock Island Arsenal became the winning candidate as a suitable site. Built on an island in the Mississippi River, it is a central location geographically, and the "Quad Cities" surrounding it—Davenport, Rock Island, Moline, and East Moline—provide ample hotel accommodations for visiting students.

Col. Walter W. Warner, Rock Island's commanding officer, responded sympathetically and helpfully and, with the assistance of Capt. Norman Allhiser, a Reserve officer on active duty who had been a professor of industrial engineering, completed the physical arrangments.

The last hurdle was the appointment of a director. Here Ordnance was fortunate to lease the talents of Dr. Mundel who had served on the original management committee. At General Ford's request, President Frederick L. Hovde of Purdue University granted Dr. Mundel a leave of absence so he could accept the new position. Dr. Mundel's own ready acceptance of the directorship put the school in high gear, and classes first met on April 21, 1952.

The Curriculum

The school's curriculum consists of nine courses. The basic group of courses which principally deal with improving the efficiency and economy of specific jobs and single operations are methods improvement, work measurement, procedure analysis, and management statistics. The next group includes the control courses—production planning and control, organization analysis, and manpower control—which plot the layout and coördination of operations and the optimum utilization of manpower.

Executive Courses

At the top are two "executive" courses, the management seminar which probes the highest levels of planning and the 3-day appreciation course which briefs commanding officers and civilian chiefs on what their subordinates learn while attending the school.

Most of the courses last either two, three, or four weeks. The reason for limiting the instruction to a few weeks is the difficulty in releasing Ordnance personnel from their jobs for longer periods of time. To pack a welter of problems and information into a few weeks' span, each course operates from 8 in the morning to 4:30 in the afternoon.

Instead of requiring a student to take notes laboriously, the school hands out enough printed material to fatten a briefcase to the bursting point. Likewise, the school supplements the conventional blackboard with hundreds of movies, slides, and sound recordings borrowed or bought from industrial, university, and Government film libraries.

High-Powered Course

Most high powered of the courses is the top-management seminar. As in the other courses, this one is held to a 20-man enrollment, but unlike the others it is taught by guest lecturers representing business, industry, consulting firms, and educational institutions. Sixty experts have lectured so far, some of them for the third and fourth time.

The seminar knifes into the very core of management problems, asking questions such as "When is centralization advantageous?" and "Are the terms 'power' and 'authority' synonomous?" and "What fundamental principles must be followed for the development of effective committees?"

The other courses focus on less abstract phases of management and encourage what Dr. Mundel calls "fractionating a problem" or "giving it specificity." The student, utilizing scientific procedure, breaks down the problem under discussion as a chemist separating elements hypothesizes an acceptable answer.

Although the school makes learning as painless as possible, each student must read and report on assigned books. The student also puts into practice his classroom knowledge by tackling specific projects in Rock Island's shops.

To improve public speaking, the school, in many cases requires a student to record the results of his project on tape. During the playback, the class hears the report while the student sizes up the effectiveness of his public speaking.

The school's criteria for judging the success or failure of a project are a mixture of idealism, sure-fire concepts, and rules of thumb.

To illustrate, in the area of staff organization the school suggests three ideal relationships: Every man must have only one boss; every man must know the limits of his job; and every man should keep his boss informed. Easy to establish these relationships, isn't it? In actuality, it is just the opposite; few organizations can honestly say they have firmly established these relationships.

A useful concept in the methods-improvement field is a breakdown of production engineering changes by complexity. The simplest change would be an alteration in hand and body motions. A more complex change, involving outlay of money, would be new tools and equipment.

Increasing Complexity

The remaining three changes, each increasing in complexity, would be shifting the sequence of operations in a production process, redesigning the product itself, and substituting one raw material for another.

The handiest guide for estimating the value of a management idea is a check-off list put together by the school. Will the idea or project mean fewer people, less idle time on equipment, less in-process inventory, fewer forms, less cost, better control, better planning, less materials handling, and more accurate information? The more factors influenced in a positive direction by the idea, the better rating the idea gets.

The school shies away from pat answers. Management is like psychiatry—every case is individual. The man from one installation may be frustrated by a peculiar labor market, another man may suffer from the dilemma of excess paperwork, and so on.

Consequently, the school acts as diagnostician, describing the illnesses in management that are common to all installations but facing individual problems with an open mind.

The school's special "bedside manner" is to provide coffee breaks, restful armchairs, fluorescent lights, and similar conveniences, on the assumption that the comfortable student is the most receptive and articulate.

By the end of several weeks, the student finds himself refreshed with a new attitude toward management and a capacity for talking about "curves of probability" and "behavioristic psychology."

Results Pouring In

What does this experiment add up to? The results are flowing into the Office of the Chief of Ordnance and the school headquarters. First, graduates initiate money-saving projects upon return to their home installations.

Secondly, each graduate is a potential instructor. Armed with a teaching outline which the school gives him on his departure, the returning graduate can establish management training at the local level.

Thirdly, a host of small but significant improvements evolve from having OMETP-trained personnel working at installations.

One project sliced in half the work force on a production line at an arsenal. Another cut paper work in a district by ten per cent. The roster of accomplishments is long. Savings have been as small as $100 and as large as an estimated $500,000.

Invisible Gains

It is virtually impossible to assess the school's value in pure dollars and cents. Invisible gains radiate in all directions—horizontally across the staff level and vertically down to the machinist.

Call these unseen accomplishments "better morale" or "enlightenment" they all boil down to a policy of management whereby the human factor —the relationship of operator to operator, manager to assistant manager, civilian to military—is foremost in production planning. The approximate cost per graduate: $100.

"Ordnance in the Atomic Age," was the theme of the Thirty-fifth Annual Meeting of the American Ordnance Association held at Aberdeen Proving Ground, Md., on October 8, 1953. More than 4,000 members of the A.O.A. gathered on a perfect fall day to witness a demonstration of modern weapons and equipment used by our fighting forces. The morning program was devoted to tests of small arms, aircraft and antiaircraft weapons, body armor, mortars, recoilless rifles, and rocket launchers.

The noon hour featured a lunch of fried chicken and visits to the static displays presented by the following divisions of the proving ground: Automotive, Laboratory Services, Arms and Ammunition, Library and Museum, and the Ballistic Research Laboratories.

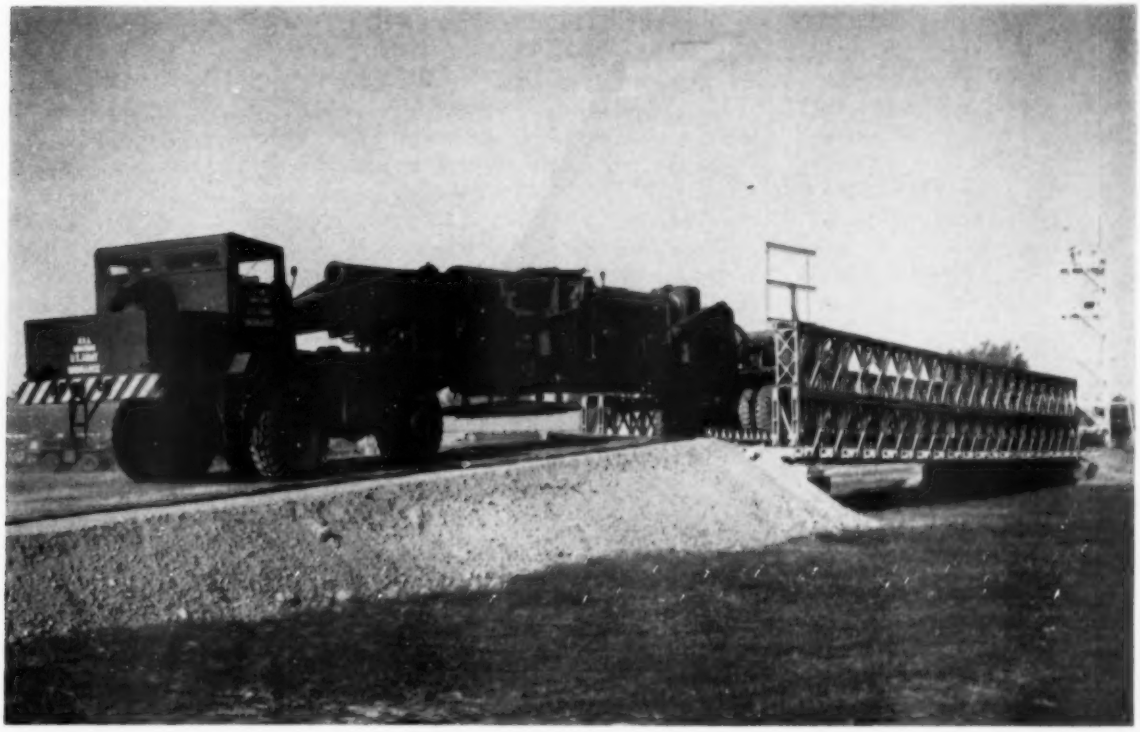
During the afternoon, the A.O.A. members witnessed a demonstration of captured Soviet matériel, tank recovery, and maneuvers of our latest trucks and armored vehicles. The climax to Ordnance Day 1953 came when two huge 280-mm. "atomic" cannon were transported across country, emplaced, and fired in approximately twenty minutes. The Army photos on these pages show a few of the many highlights of the Annual Meeting.

Ordnancemen at Aberdeen

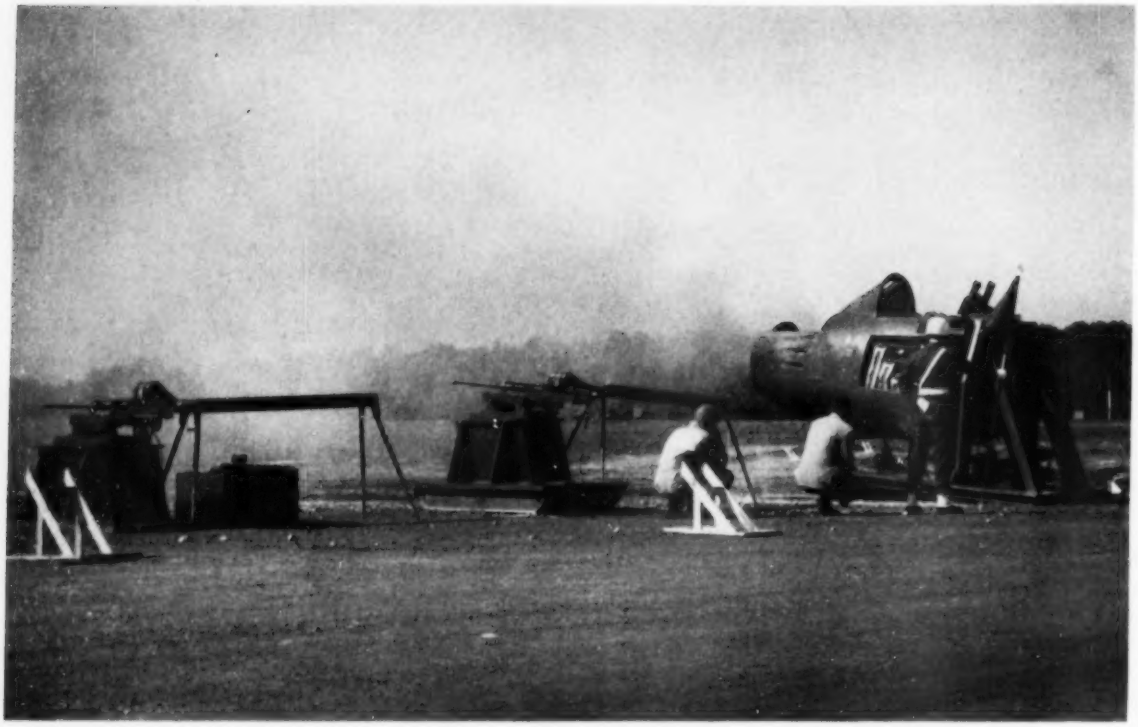
Among those watching the demonstrations at the Thirty-fifth Annual Meeting of the A.O.A. were, left to right above: Gen. Matthew B. Ridgway, Army Chief of Staff; Maj. Gen. E. L. Ford, Chief of Army Ordnance; H. R. Boyer, general manager, Cadillac Tank Plant, Cleveland, Ohio; and Lieut. Gen. Levin H. Campbell, A.O.A. president. Below, other Ordnancemen inspect a tank.

Long-Range Weapons

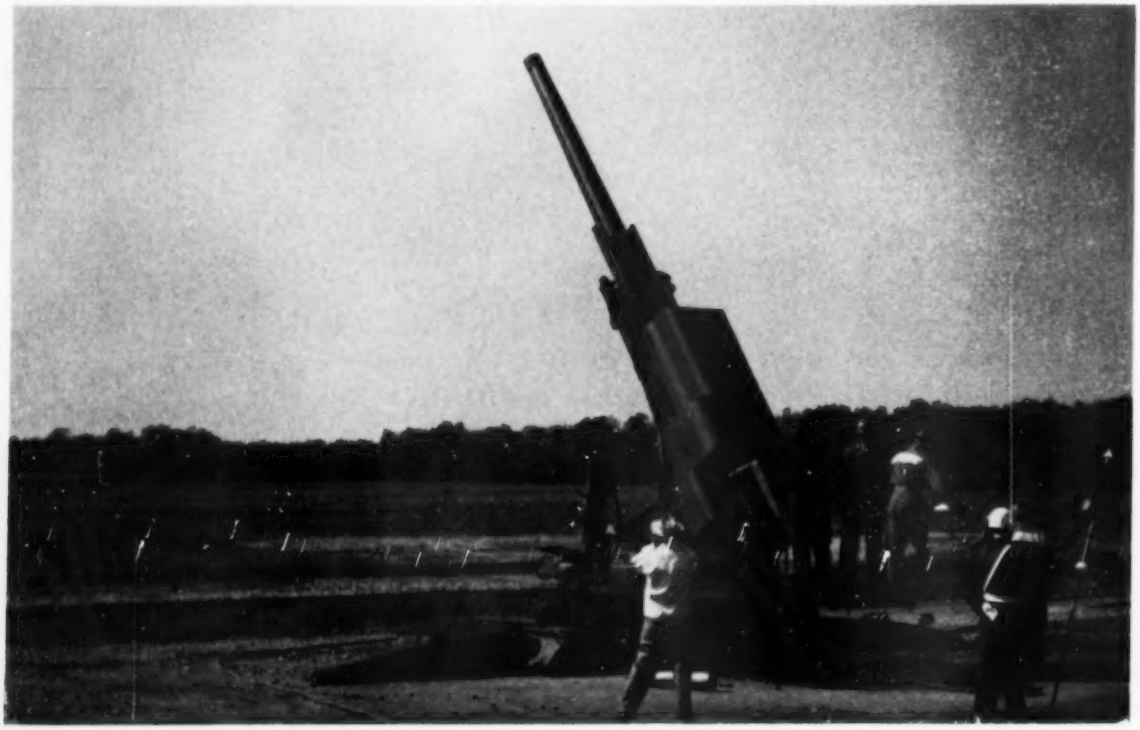
The 155-mm. mortar T17E2, above, is one of the Army's largest. It is trigger-fired and sends a heavy shell to a range of 6,000 yards. The 280-mm. atomic cannon is shown below being transported across a Bailey bridge by its two prime movers. Despite its great size and weight, the weapon has good cross-country mobility and can be emplaced and fired quickly.



Aircraft and Antiaircraft Guns



Six caliber .50 M3 machine guns are being fired from the nose of an F-86 fighter airplane at right, above, while two 20-mm. aircraft cannon, M24A1, at left are ready for demonstration. Below is the Army's largest mobile antiaircraft gun, the 120-mm. M2, which employs the M33 off-carriage fire-control system. This weapon is for defense against high-flying enemy aircraft.



Ordnance Maintenance in Germany

Rebuilding Army Equipment in the European Theater

Col. Philip Schwartz

DURING the 1952 rebuild of Ordnance equipment in Europe for delivery to NATO countries under the Military Defense Assistance Program, a number of lessons were learned concerning Ordnance maintenance, some of which are described here.

All Facilities Used

To complete the rebuild program of approximately 60,000 tanks and wheeled vehicles and their accessories, including guns and fire-control equipment, all available USAREUR facilities were used. The following were some of the many problems raised early in the program: proper standard of quality, relative cost and time required for rebuild and repair, difference in meaning of such maintenance terms as repair, overhaul, rehabilitate recondition, and rebuild.

Personnel responsible for implementing the program at the working level raised questions concerning the difference in meaning of "tear it down to bolts and nuts and then build it up again," "if it rolls put paint on it," "if it's good enough for the 7th Army it's good enough for NATO countries," "an Ordnance standard," a 461-462 standard, and, finally a second-, third-, fourth-, or fifth-echelon standard of quality.

For use in this article and for general information of the reader an unofficial tabulation has been prepared (see p. 412) which describes the various echelons of maintenance. It differs from other similar tabulations by the addition of a column showing echelons of preventive and curative maintenance applied to personnel. Although this column is not applicable to Ordnance equipment, it does illustrate the universality of the echelon breakdown of maintenance responsibility.

When lower echelons perform their maintenance responsibilities properly, higher echelons have less work to do. When equipment operators perform their preventive-maintenance duties regularly and properly, they are less likely to have a breakdown requiring help from second echelon or higher echelons of maintenance.

Similarly, when organizational second-echelon maintenance is performed properly, there is less work for the third and higher echelons.

Special Appeal

Although such an explanation may sound reasonable to the user, it appeals especially to the direct-support Ordnance maintenance unit. Since Ordnance maintenance and supply personnel are limited in number (about four per cent of the total strength of a field army), they will be swamped with maintenance work if the equipment operator or his organization is careless in using equipment or applying preventive maintenance.

An officer who recently commanded an artillery battalion in Korea told this writer that keeping his equipment in rolling and firing condition was so important to him that he spent an extremely large part of his time following up on maintenance. A graphic illustration that indicates where that maintenance should be performed is shown qualitatively in Figure 1 appearing on page 413.

Too many Ordnance personnel associated with arsenals, depots, and rear areas have the wrong impression of who should do, or who actually does, most of the maintenance of Ordnance equipment. A recently implemented program of the Army to indoctrinate general and other senior officers with the importance of preventive maintenance at operating levels should help to clarify this misunderstanding.

When General Eisenhower, then SHAPE commander, announced that he was not satisfied with the rate at which equipment was being furnished to NATO countries, Washington put pressure on USAREUR rebuild organizations to help expedite the completion of the MDAP rebuild program in Europe. Desired completion date was set by Washington as the end of the calendar year 1952.

At first this seemed to be an impossible target for Ordnance rebuild. The USAREUR theater Ordnance Officer soon decided that it would be necessary to use other than the current fifth-echelon methods because they were considered to be too time-consuming.

Adopted in 1946

These fifth-echelon methods were adopted in 1946 and 1947 in Germany at a time when German workmen had little to do and were suffering because of lack of food. By 1952 the food situation had bettered to such an extent that fifth-echelon methods were sometimes considered to be an expensive luxury.

Third-echelon methods were accordingly used at maintenance depots and other installations in order to prepare more equipment for delivery to NATO countries in 1952. A quality standard was adopted which required that all equipment be acceptable in accordance with the well known 461-462 series of inspection forms for RFI (ready for issue) Ordnance equipment.

Colonel Schwartz, until his retirement a few months ago, was serving in the office of the commanding officer, 7848th Ordnance Maintenance Group, U. S. Army, Germany.

The fifth-echelon depots which adopted third-echelon procedures in the first part of 1952 were surprised to find that sometimes it took little more time to apply the fifth-echelon methods than the third-echelon methods, although the quality of the product was always higher when fifth-echelon methods were used. The depots continued to use fifth-echelon methods on equipment which was very badly damaged when it was received at the depot.

Third-Echelon Methods

Where the equipment at the time of receipt at the depot was in serviceable or near-serviceable condition (as much of it was because it had just been turned in by organizations which had been using it every day), third-echelon methods were used.

Fifth-echelon depots were further surprised to find out that although they had no difficulty in turning out a first-class fifth-echelon job, they did have difficulty in finding in their depots personnel skilled in third-echelon work. This was due to the fact that it was customary in third-echelon work for one mechanic to repair all or most of a piece of equipment with comparatively little help from any one else, except possibly specialists such as carburetor men and welders.

Skilled Men Scarce

Skilled third-echelon men were scarce at fifth-echelon depots, because fifth-echelon mass-production methods permitted the work to be broken down into a large number of highly specialized "operations."

Fifth-echelon depots used a large number of operators and a small number of setup men. Fifth-echelon operators could be trained in a few months, whereas third-echelon mechanics required many years to reach the skilled stage.

It is worth noting here that fifth-echelon depots used many more specialized labor-saving devices than did the ordinary third-echelon installation. The German mechanics at the depots in Germany were proud of the high quality of their fifth-echelon work; they sometimes bragged that the product of their depots was almost as good as a newly manufactured item.

Echelon of Maintenance	*Official Maintenance Nomenclature*	*Type of Maintenance*	*Equipment Maintenance Performed by*	*Corresponding Maintenance of Personnel Performed by*
1	Organization	Preventive only	Operator of equipment	Man himself
2	Organization	Preventive and curative	Using organization	Home or family
3	Field	Curative	Supporting maintenance organization	Doctor
4	Field and depot	Curative	Special supporting heavy maintenance organization or depot	Doctors or outpatient part of hospital
5	Depot	Complete and special curative	Arsenal or depot	Inpatient part of hospital

Unofficial tabulation comparing mechanical and personal echelons of maintenance.

An attempt has been made in Figure 2 to show how maintenance skill varies with the different echelons of maintenance. The graph shows that third- and fourth-echelon mechanics normally require more knowledge of maintenance than do fifth-echelon operators.

Wherever it was possible in fifth-echelon work the work was always moved to the operator, the operator being fixed as in normal mass production. This procedure of moving the work to the operator was also tried for third-echelon work but was not found too successful. Because of the shortage of skilled third-echelon mechanics in the fifth-echelon depots, a method was sought which permitted the use of personnel having less skill than all-round third-echelon mechanics.

This was found to be possible at fifth-echelon depots by dividing the work into specialties and then training certain personnel in each of these specialties. The work was then fixed in place for the most part, and the operators who had been given specialized training moved to the place where the work was located.

This procedure was especially desirable when dealing with heavy equipment such as a 40-ton tank. The result was a comparatively efficient organization in which advantage was taken of basic mass-production principles.

Ten Large Plants

In Germany there were ten large Ordnance maintenance depots in 1952 and 1953. They employed more than 15,000 German civilians. They were operated by about one hundred Ordnance officers with help from a comparatively small number of enlisted men and American civil-service employees.

These depots produced rebuilt tanks, tractors, artillery, antiaircraft guns, small arms, bazookas, optical and other fire-control equipment, engines and power trains for trucks and tanks, all types of trucks, trailers, buses, and passenger cars.

The depots were located in the Munich area, the Stuttgart area, and the Frankfurt area of the U.S. Zone. Some of the German employees were hired through the local area administrative headquarters of the U.S. Army. Others (the majority) were hired by a German personnel contractor who took care of labor problems peculiar to Germany for the depot commander but did not operate the depot.

This latter method of obtaining

German personnel was found to be better than the method of hiring through a U.S. Army administrative headquarters. It was better because it obtained better supervisory personnel, paid the workers wages more comparable with that of civilian industry in the local area, gave the workers such social benefits as were customary in German industry, protected the German worker from being called a collaborator with occupying military forces, and above all it simplified the labor-relations problems of the depot commander.

Incidentally, in all the maintenance depots, the over-all average take-home pay was about thirty-eight cents an hour, with a working week which varied from forty to forty-eight hours.

Personnel Problem

One of the problems in the German depots was to make adequate use of U.S. military personnel without disrupting the work of the German employees. After German employees had worked at a depot for several years, they became skilled in their work and compared favorably with civilian employees at arsenals and depots in the United States.

A chain of responsibility was normally adopted at each depot which went from the commanding officer to the senior German supervisor, and from him to subordinate German foremen.

Officers assigned to depots functioned as the eyes and ears of the commanding officer. They were useful especially when something out of the ordinary appeared which required an investigation of some kind or a decision which German employees were not authorized to make.

Enlisted men who were assigned to depots were found to be most useful as final inspectors of the product of the depot. When enlisted men were used at depots for other than inspection work, they ultimately competed with the German workers which was considered to be undesirable for many reasons. Department of the Army civilian employees (U.S. citizens) were given the same responsibilities as officers.

For duty at these maintenance depots all officers should preferably be engineers and all enlisted men mechanics; otherwise it is difficult for Ordnance officers and men to participate actively in the work of the depots. Where Americans were used only as office personnel or as operators of trucks or as guards or in similar administrative work, the German workers and foremen had comparatively little respect for the Americans.

Indeed, one of the German contractors who hired and fired German personnel at one of the largest maintenance depots claimed at one conference that all the technical activities at the depot were supervised by Germans and that Americans took care only of administrative matters.

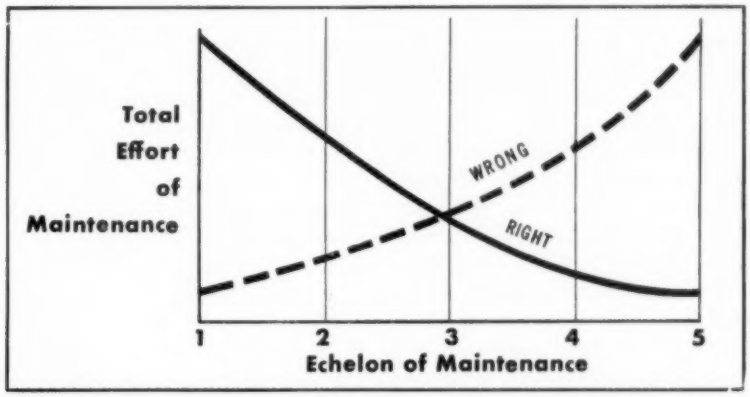
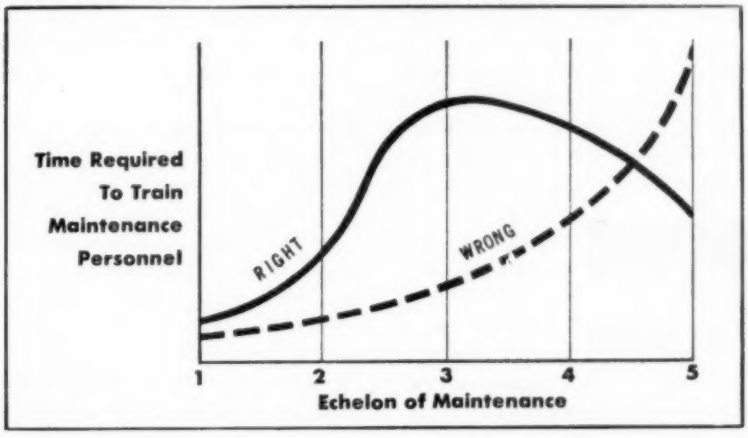


Fig. 1, above, represents correct and incorrect types of maintenance at various levels. Fig. 2, below, indicates variety of maintenance skills required at different echelons.



Special Regulation

A special regulation has been published which directs that Army depots be organized in accordance with a fixed organization chart. This regulation was apparently built up around a Quartermaster-type of supply depot. Yet it has been prescribed that a depot (in a theater) whose principal function is rebuild of tanks, guns, or motor vehicles, must be organized in exactly the same manner as a Quartermaster supply depot.

One of the peculiar results of this requirement is that the principal operating assistant of the commanding officer of a depot whose sole function is fifth-echelon maintenance, must be called "Assistant for Supply Operations." Maintenance depot commanders must post in their offices an organization chart prepared in accordance with this special regulation for exhibition to inspectors (who require this kind of a chart) and to visitors.

However, maintenance depot commanders may make little use of this chart.

It was found at maintenance depots in Germany that detailed manufactur-

ing drawings of equipment were indispensable. In the absence of drawings of parts which were not available in Europe, it was necessary to prepare drawings of the parts in Europe. Such drawings were then used to make the parts either at depots or at plants of German manufacturers.

German Draftsmen

The drawings were made by German draftsmen based on examination of one of the parts. The draftsman estimated the physical and chemical characteristics of the raw material of the part, measured the various dimensions, and finally adopted some more or less standardized clearances and tolerances. These clearances and tolerances were in general not the same as those prescribed on the original U.S. manufacturing drawings.

As a result of such discrepancies, parts manufactured in Germany were often rejected because they did not fit properly. Often tolerances were set by the German draftsman as smaller than really required so that the cost of the part was increased.

During 1952 a recommendation was made to the Chief of Ordnance in Washington that a set of manufacturing drawings be procured from the manufacturer for each major item newly procured in the United States. If the manufacturer claimed that some of the assemblies had confidential phases (confidential to the manufacturer) drawings of such confidential phases could be omitted, thus eliminating any possible objection of the manufacturer to furnishing drawings to the Government. These confidential drawings would seldom be more than a small percentage of the total.

Additional Copies

Using the set which the Chief of Ordnance had procured as an original copy, additional copies could be made for the overseas theater Ordnance Officer whenever the corresponding equipment was first sent to his theater.

The theater Ordnance Officer could then make locally such additional copies of individual drawings as he might need for maintenance parts or for trouble shooting. Trouble shooting

> **"When lower echelons perform their maintenance responsibilities properly, higher echelons have less work to do. When equipment operators perform their preventive-maintenance duties regularly and properly, they are less likely to have a breakdown requiring help from second echelon or higher echelons of maintenance.**
>
> **"Similarly, when organizational second-echelon maintenance is performed properly, there is less work for the third and higher echelons. . .**
>
> **"Since Ordnance maintenance and supply personnel are limited in number, they will be swamped with work if the equipment operator or his organization is careless in using equipment or applying preventive maintenance."**

on new equipment is helped tremendously by manufacturing drawings.

The airplane of 1917 had comparatively few controls and few instruments—not many more than a horse. Accordingly, its operator could be trained in a short time. Maintenance problems, although existing at the time, were simple compared with similar problems.

The airplane of 1953 horrifies the average nonflier who sees the pilot's cockpit for the first time. The pilot seems to be surrounded by scores of instruments and control handles. There are so many that the nonflier cannot understand how one or even two men can watch all these instruments and controls adequately, and he reaches the conclusion that the man who pilots the airplane must be a well-trained technician. The nonflier also concludes that the man who repairs these many controls and instruments must be a high-grade engineer and/or mechanic. However the pilot may have only a sketchy knowledge of how the many black boxes full of electronic equipment are designed or repaired, from which one may conclude that airplane maintenance must require a high order of knowledge and experience of complicated technical matters.

Antiaircraft artillery fire-control equipment now being issued has similar complications of operation and maintenance.

Military Maintenance

All equipment used by the military until the 1940's has been of such nature that it could be operated and maintained by military personnel. There has never been any objection to having design and manufacture of military equipment accomplished by a civilian organization, provided that the equipment satisfied the needs of the military. But operation of the equipment had to be by military personnel, if it were to be used in combat.

Similarly it has always been assumed when military equipment broke down under combat conditions that if the equipment were reparable it could be repaired by military personnel not too far away from the place where the breakdown occurred.

In World War II and in the recent Korean struggle certain very complicated types of equipment were maintained in the combat theater largely with the help of civilian technicians. As military equipment becomes more and more complicated, it may be expected that civilian technical personnel will be used more and more in the combat theater for maintenance of such equipment.

The future may even see military equipment of certain types become so complicated that it will be necessary to have civilian help in assembling, operating, and firing it in combat areas. In the past it has always been possible to overcome the difficulties of operating and maintaining newly issued equipment, but this may not necessarily be true in the future.

Examine Drawings

Equipment which happens to work satisfactorily in the laboratory may break down in the field and provide many maintenance headaches. For this reason it has been suggested that manufacturing drawings should be examined and approved by a qualified maintenance engineer before production starts in order to minimize maintenance problems in the field.

Large enough to house a 5-story building, the Propulsion Wind Tunnel is still under construction at Tullahoma, Tenn.

The Rôle of the Arnold Engineering Development Center

John A. Killick

IT is hard for the casual visitor to the Arnold Engineering Development Center to reconcile the fact that such intangibles as control of upper space and the continued dominance of American air power ultimately may be greatly influenced, if not actually determined, in the vast, sprawling repository of scientific and technical equipment and skills that is now arising from "The Barrens" of south central Tennessee.

Impressive Array

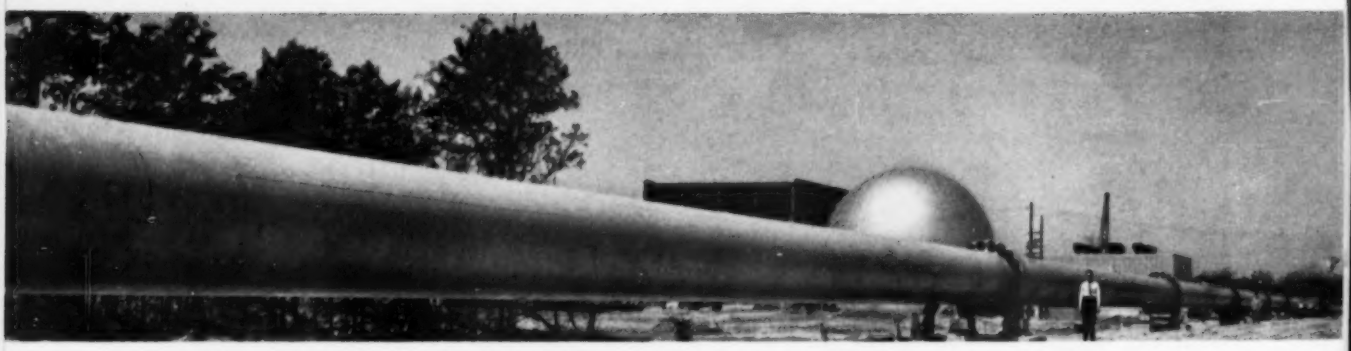
What the visitor sees is an impressively functional array of structures of recognizable form and shape, even though their size and scope are staggering. What cannot be seen, and what takes unusual comprehension to grasp, is the vast complex of testing mechanisms and techniques, many as yet unfinished and all as yet undeveloped, which will translate today's theory into tomorrow's reality—the reality being tomorrow's aircraft, both civil and military, with military needs taking initial priority.

Mr. Killick is the former editor of *Armed Force*, a military news weekly. He is now associated with the Fairchild Engine & Airplane Corporation and is a contributing editor of *Pegasus*, a Fairchild publication.

At Tullahoma, about midway between Nashville and Chattanooga, is the end product of an apprehension that was generated almost ten years ago in the minds of our military leaders when they felt the impact at first hand —in the buzz bombs and jet fighters of the Nazis—of the penalty of allowing an enemy, or a potential enemy, to gain technical supremacy over the United States.

Reason for Existence

The key to the "Why?" of AEDC can be found in the word "Development" in its name. This also answers the often-asked question as to why this gigantic installation is not a duplication



This 720-foot steel tube plus the sphere in the background provide the necessary "jolt" to reach hypersonic airflow speeds.

of existing scientific laboratories. There are, it is well known, other facilities in the Nation with capabilities equal to those which will be realized by AEDC at its completion. There are wind tunnels with capacity to delve into supersonic and hypersonic problems.

The concept underlying AEDC, however, is that, first, it will permit laboratories intended for pure and basic research to concentrate their energies and efforts in this field, and, secondly, that it will be able to carry certain aspects, at least, of development of these theories farther and faster than any existing installation.

Almost Fatal Mistake

For it was in this area that the Nation committed an almost fatal mistake in the years preceding World War II. When the urgencies of war struck, the research facilities which should have been able to produce the buzz-bombs and the jet fighters which the Nazis *did* produce were so overloaded and preoccupied with developmental tasks that they were physically incapable of keeping pace with the basic research for which they were originally designed and intended.

The lack of a counterpart of AEDC at that time conceivably could have cost the Nation victory.

Another word in the installation's name—"Arnold"—gives the clue to this little-known history, because it was the late Gen. H. H. Arnold, then leader of the U. S. Army Air Forces, who asked Dr. Theodore von Karman "to investigate all the possibilities and desirabilities for postwar and future war's development as respects the Army Air Forces."

His formal request was made in November 1944, just after the V-2 had superseded the V-1 that had rained destruction on Britain for eighty days and just about the time that Allied leaders began to realize that German jet plane development was well in advance of similar craft then being developed in the Allied arsenal.

Not that AEDC is all that General Arnold dreamed, nor is it all that Dr. von Karman recommended. The original idea has gone through many transmutations, modifications—and legislative wringers—and came into being at all only through the potent and persistent backing of such groups as the Research and Development Board, the National Advisory Committee for Aëronautics, and the President's Air Policy Commission.

Even today, legislative and budgetary as well as political hurdles have foreshortened the perspective that existed when ground for the Center was finally broken in the autumn of 1949.

For the past four years construction of the Center has been progressing under the supervision of the U.S. Army Corps of Engineers, specifically through the Tullahoma Engineering District which was created to manage this particular project. Despite budgetary setbacks and the interjection of an unanticipated incident in Korea which took considerable priority in manpower and materials, the rate of progress is considered satisfactory by those who are aware of the problems that have been encountered.

To realize the magnitude of these problems it is necessary to have some idea of the Gargantuan scope of the project as it will exist when completed. The Arnold Engineering Development Center will eventually consist of:

Engine Test Facility

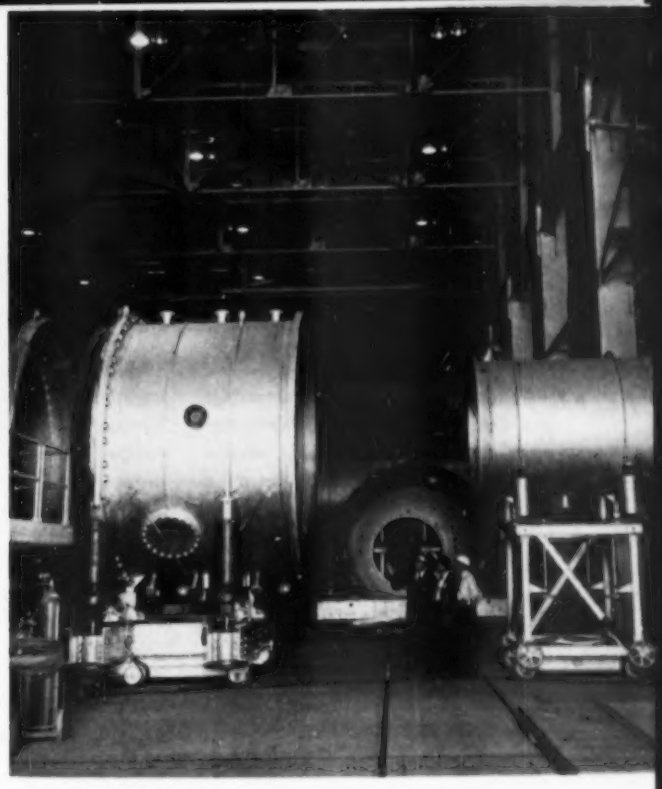
The Engine Test Facility (*ETF*) for development and evaluation programs on turbojet, turboprop, and small ramjet engines under simulated flight conditions at all altitudes up to 80,000 feet. To this there has subsequently been authorized the *Ramjet Addition* (*RJA*), in which the largest ramjet engines now contemplated can be tested.

The Propulsion Wind Tunnel (*PWT*) for developmental testing of full-scale, operating ramjet and turbojet power plants installed in missiles or aircraft and for the testing of propellers and aërodynamic models in two large tunnels—one transsonic, one supersonic —and a scale model of the test section of each tunnel.

The Gas Dynamics Facility (*GDF*), for developmental testing, in a group of supersonic wind tunnels, of models of aircraft, projectiles, and missiles designed to operate at extremely high speeds, with some of the tunnels capable of simulating a hypersonic range of more than five times the speed of sound, to provide test data for test articles over widely varying speed, altitude, and temperature conditions, so that full-scale characteristics of the test articles can be more readily ascertained.

Of these, the only one nearing physical completion in its entirety is the Engine Test Facility, which, at sum-

When completed, this trench will hold vital equipment for the Gas Dynamics Facility of the testing center.



Technicians, above, inspect part of the tremendous equipment used to operate the Engine Test Facility.

mer's end was about ninety-eight per cent finished in so far as design was concerned and about ninety-five per cent constructed. It should be borne in mind, however, that even one hundred per cent completion physically still does not begin to give an approximation of when actual testing can begin, because there will still be long months, perhaps years, of calibration, adjustment, modification of control systems, and the integration of test data into productive form.

One Tunnel Operating

In addition, one tunnel of the Gas Dynamics Facility is now operating, although GDF itself was rated, in the late summer, as only forty per cent complete. This tunnel, known as E-1, is a duplicate of one at California Institute of Technology, and its 12-by-12-inch test chamber will eventually realize a speed range between Mach 1.2 and Mach 5.0.

Only about twenty-five per cent of the Propulsion Wind Tunnel had been finished at the time the preceding estimates were made, and the Ramjet Addition to the Engine Test Facility is scarcely out of the design stage, although basic construction has actually begun.

Words Fail

Mere words fail to give any conception of the size and complexity of the components of the Development Center. An area 150 yards wide and 200 yards long, for example, is needed to encompass the Engine Test Facility alone.

ETF will have these basic components: refrigeration drying equipment, four air supply compressors, three test chambers, and a test bed, exhaust gas coolers and six exhausters—the last-named being valved so they can be used in series, series-parallel, or parallel flow. The entire air-flow system can be routed through the heaters of the Ramjet Addition and can be boosted by its two 15,000-horsepower compressors.

This complicated network is required because the air drawn from the atmosphere must be compressed and cooled and dried before being directed into the test chambers. The simulation of high-altitude temperature may call for air that has been cooled, originally, to as low as 120 degrees below zero Fahrenheit.

Contrariwise, the air must be dried and circulated through heat exchangers, which draw upon heat generated by compression in order to meet the higher temperatures called for to represent supersonic ram conditions.

Valve regulation can accomplish an inlet temperature range of from minus 120 degrees to plus 300 degrees Fahrenheit, but for the higher temperatures called for by supersonic ram conditions the air must be routed through oil- or gas-fired heaters capable of producing temperatures as high as 650 degrees Fahrenheit.

More Space Required

More than twice as much area is required for the Propulsion Wind Tunnel as is needed for ETF because of the massive tunnel itself. PWT occupies an area 1,000 feet wide by 1,200 feet long, and the tunnel has a diameter of 55 feet.

The strength of this massive tube can be realized by the fact that it must be capable of containing a stream of

air approximately equivalent to the air-swallowing capacity of 350 F-80 fighters at full power at sea level. The cooling system for the temperature control of PWT will use water at the rate of about 150,000 gallons a minute (a rate equal to the consumption of the population of a city the size of Washington, D.C.).

Much Equipment

While the tunnel is the spectacular and easily visible aspect of PWT, there must also be tunnel ducting, nozzles, a precooler and aftercooler, combination systems for the scavenging of combustion products from burning power plants, systems for providing make-up air, a compressor system, optical instrumentation systems, force-measuring systems, cover for each test section, and cover for the electrical drive components, in addition to the required office buildings.

Two wind-tunnel circuits—one transsonic, one supersonic—are being built into PWT. The compressors for these are the largest rotating machinery ever constructed in the United States, and they were installed last summer only by the expedient of lifting the roof off the building.

Air velocity in the transsonic test section will be controlled by a nozzle with flexible walls 16 feet high and 57 feet long, and the pressure in both circuits can be varied from 2 atmospheres to that equivalent to an altitude of 100,000 feet.

Test section carts 40 feet long will convey test objects on railway tracks to the 16-by16-foot test sections, a size twice that suggested in the original Research and Development Board estimates back in the post-World War II 1940's. Several interchangeable test-section carts will enable test articles to be installed and made ready for tests without interfering with tests already in progress and with a minimum loss of time.

The size of the test chamber, 16 by 16 feet, resulted from the conclusions of the best scientific and technical brains available that this would fulfill the maximum needs of the foreseeable future. Likewise there have been revisions in the original Mach spread. At first the plans envisioned a range between Mach 1.2 and 2.6. As presently projected, the Mach number range will cover the area between Mach .8 and 3.5.

As important to the technicians at Tullahoma as they are unintelligible to the average layman are the Reynolds-number capabilities of the PWT and the Gas Dynamics Facility.

Without getting involved in scientific mumbo jumbo, a Reynolds number is a gauge of comparison to actual flight conditions, with the higher the Reynolds number the greater the approach to actuality.

A Reynolds number is obtained—this is admittedly oversimplification—by multiplying the size (of the object being tested) times velocity (of either the model or the airflow) times density of the air, and dividing the result by the viscosity (or stickiness) of the air.

High Reynolds Numbers

One of the advantages which AEDC technicians believe will be achieved by the Gas Dynamics Facility will be the attainment of high Reynolds numbers by the use of fairly large test sections, but, more importantly, by the more economical and convenient method of increasing the pressure of the air to more than 100 atmospheres at high Mach number so that Reynolds numbers approaching the performance of actual missiles in flight will be provided over most of the Mach-number range.

Both supersonic and hypersonic wind-tunnel capabilities have been designed into the Gas Dynamics Facility to enable not only testing of models of supersonic aircraft and guided missiles now being developed, but also, in the Mach 5 realm and above, experimentation with longer-range, higher-speed missiles which may be conceived for offensive use.

Like all else at the Arnold Engineering Development Center, the Gas Dynamics Facility is complicated and power hungry. It will have a vertical compressor plant, six axial and six centrifugal compressors, plus an auxiliary compressor group which includes vacuum pumps and centrifugal and reciprocating processors to feed a vacuum sphere and high-pressure air storage tube which augment the main plant.

The sphere and the tube are distinctive, eerie features of the AEDC landscape, but they perform a unique function in GDF. The sphere, 72 feet in diameter, and the correlated, though separate, 720-foot tube, 4 feet in diameter, give the "jolt" necessary to shove air flow up into speed ranges difficult of attainment, and the use of the two devices in combination can insure the steady pressures indispensable to accuracy in testing.

The tube, which weighs about one ton per running foot, is capable of containing and sustaining pressures up to 4,000 pounds to the square inch.

At GDF is the completed tunnel, E-1, mentioned earlier, which has been turned over to the Center's operating personnel to begin calibration and adjustment of its flexible steel nozzle which will provide unusual versatility in the testing of models.

To operate this tunnel, plus E-2 and at least two others which are contemplated, will require the usual inordinately complex outlay of driers, precision optical instrumentation, delicate force- and pressure-measuring mechanisms, and, like all else at AEDC, a staggering amount of electrical power.

466,000 Horsepower

If, by this point, the power and water appetites of the components of AEDC have become incomprehensible, it is small wonder. At the Engine Test Facility approximately 75,000 horsepower will be required to operate the compressor and exhauster system, with an additional 75,000 horsepower needed at peak conditions to provide the necessary air flow for ETF's Ramjet Addition. The world's largest electrical motors, capable of 216,000 horsepower, are in the Propulsion Wind Tunnel system. At the Gas Dynamics Facility it takes 100,000 horsepower to run the show. That's a total of 466,000 horsepower, or a potential demand more than 2⅓ times greater than the normal needs of the entire city of near-by Nashville.

Similarly Gargantuan are the water needs of the establishment. Initially, the 3 installations will call for 150,000 gallons of water a minute, and the system had to be developed so that it would be capable of eventual expansion to a rate of 250,000 gallons a minute. Supplying the water for the cooling and sanitation demands of the 42,000-acre Center called for the building of a 2,943-foot dam, with a maximum height of 90 feet, to provide a reservoir with a minimum of 80,000 acre feet of storage capacity.

Compelling Factors

Obviously, the AEDC power and water demands were compelling factors in the selection of Tullahoma—in the Tennessee Valley Authority area—as the site for the Center, and the added security of central, inland location was not to the community's disadvantage.

Thus far the emphasis in this article has been on the "what" and the "where" and the "how," with little attention paid to the "who" and, except for a brief reference at the outset, to the "why."

Although AEDC is a military installation, under the purview of the United States Air Force as one of the nine major components of the Air Research and Development Command, it is intended to augment and supplement all endeavors in the realm of the aëronautical sciences.

To put it another way, its facilities are intended for the use of the other military services and governmental agencies and for the benefit of industry.

To help attain this end, Gen. Hoyt S. Vandenberg, while Chief of Staff of the Air Force, set up in September 1950 the Industry and Educational Advisory Board and left wide latitude to the board to recommend policies for the use of the Center's developmental facilities by industry, as well as to consult with the commanding general of the Arnold Engineering Development Center, the Commander of the Air Research and Development Command, and the Chief of Staff of the Air Force on policy matters concerning the operation and use of the Center.

The composition of the board has changed several times since it was created. At present associated with the board are John R. Markham, Massachusetts Institute of Technology, chairman; Dr. C. E. Brehm, president of the University of Tennessee; Dr. Harold Flinsch, dean of engineering, Mississippi State College. Industry memberships are held by A. T. Colwell, Thompson Products, Inc.; Paul J. Frizzell, Fairchild Engine & Airplane Corporation; Wright A. Parkins, Pratt & Whitney Aircraft Division; Kendall Perkins, McDonnell Aircraft Company; Maj. Gen. E. M. Powers (USAF, Ret.), Curtiss-Wright Corporation; Edward C. Wells, Boeing Airplane Company; Neil Burgess, General Electric Company; and L. A. Hyland, Bendix Aviation Corporation.

Robert W. Kamm, who is also civilian Special Assistant to the Commanding General, AEDC, is executive secretary of the Industry and Educational Advisory Board, and comes to his post with prior experience in the Research and Development Board, the NACA, and the Glenn L. Martin Company. He provides an immediate and permanent link between the IEAB and the top military echelon in command of the installation.

Technical Skills Needed

While the military is in command of AEDC, the operation of such a facility obviously calls for highly developed technical skills and talents which would not normally be found in a sufficient number of military personnel to make possible an all-military operation.

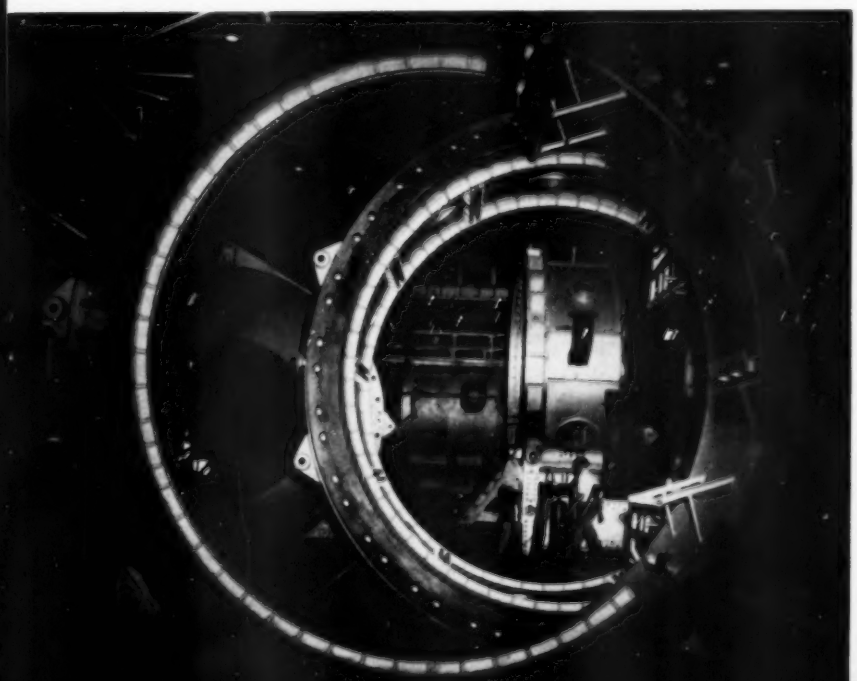
Consequently, the Air Force retained a civilian organization Aro, Inc., to design and operate the installation. Aro is a wholly owned subsidiary of the firm of Sverdrup and Parcel, and is back at the operating helm of AEDC after a brief period during which a demand for a legislative investigation caused a lapse in Aro management and the creation, temporarily, of a special operating division of Sverdrup and Parcel.

Compelling Reasons

The commanding general of AEDC is Brig. Gen. Samuel R. Harris, USAF, who gives the most compelling reasons for the "why" of AEDC. In a recent interview, he stated:

"We are, in effect, buying time here at AEDC and paying substantial sums for its purchase. If our work here, however, can save as little as six months —or even one 'day under certain circumstances—in the development of an idea or a device which will guarantee a greater degree of national security, then I feel that there can or will be little quarrel with these admittedly vast expenditures.

Part of the Engine Test Facility, these tubes will funnel winds of incredible velocity in an attempt to simulate flight conditions at all altitudes to 80,000 feet.



Technicians man a camera stand to record a missile drop at Chincoteague, Va.

Testing the Navy's New Air Ordnance

Capt. M. P. Bagdanovich, U.S.N.

ALMOST yearly the advances in military aviation offer new challenges in the development of aircraft ordnance. To maximize the effectiveness of each aëronautical improvement, these challenges are exploited by the Bureau of Ordnance in a continuing research and development effort. And as a field activity of the Bureau of Ordnance, the U. S. Naval Aviation Ordnance Test Station, Chincoteague, Va., is contributing to that effort.

Area Well Suited

Located in the marshland oyster country of Virginia's eastern shore, the Naval Aviation Ordnance Test Station is a growing test and development center. Its proximity to major eastern centers while still in a comparatively isolated area particularly lends itself to the activities in which it is engaging.

Just 104 miles from Washington, D. C.; 87 miles from Norfolk, Va.; and 100 miles from Baltimore, Md., NAOTS, Chincoteague, is in an ideal position to maintain liaison effectively with the Bureau of Ordnance in Washington, with industry in Baltimore and Philadelphia, and with the fleet at Norfolk.

In addition, the unlimited availability of sea-target ranges and numerous small islands that permit erection of evaluation equipment are especially adapted to naval testing.

As its physical nearness to major centers and ranges is one advantage, the sparse population of the region is another. Essentially a fishing and farming area, the lower Delmarva peninsula on Virginia's eastern shore is all but surrounded by the Atlantic Ocean on one hand and the Chesapeake Bay on the other. For many years this isolation inhibited the growth of population so that the safety of metropolitan centers has been no great problem.

Toward the end of the last war these physical advantages of the area were taken under consideration for the site of a new ordnance test station. The demands of the jet and atomic ages in the rapidly developing field of aircraft ordnance had strenuously taxed Bureau of Ordnance facilities. Existing facilities were scattered and in some places obsolescent.

To counteract this situation, the Naval Aviation Ordnance Test Station was commissioned in April 1946. With its companion facility, the U. S. Naval Auxiliary Air Station, under the dual command of Capt. W. V. R. Vieweg, NAOTS was launched on an expanding mission which is now "to conduct research and developmental investigation, test, and evaluation of experimental aviation ordnance equipment, including aviation fire-control systems, aircraft guns and associated components, short-range guided missiles, and aircraft missile launchers; and to perform countermeasures, tests, and investigations of electronic and certain designated guidance systems including the collection of fundamental data as required by the Bureau of Ordnance."

How well NAOTS has been fulfilling that mission may be indicated by the continuing growth in personnel and facilities. Of particular importance is the development of ranges. Since the productivity of any test station is centered around ranges, their rapid development was mandatory. And the seaboard location of the station in a low-population area made their acquisition comparatively easy.

Realistic Target

From the very beginning, considerable emphasis has been placed on the check-out and testing of various guided missiles. To accomplish the testing an old Liberty ship was grounded and instrumented as a typical and realistic target.

Camera stands and other instrumentation, both on and off the vessel, determine every effect of a missile drop from every angle. Taking a pounding that

similar vessels rarely survived, this old barnacle-encrusted ship is doing a big job in the interests of defense.

Of the several low islands near by, one was found sufficiently large and above water to permit the erection of a theodolite camera system. In the final stages of completion now, this camera system will increase photographic coverage to include all types of aërial drops.

Camera Range

In another area of the island a target center camera range has been constructed for the testing of fire-control systems. And, in addition, the island is used by the National Advisory Committee for Aëronautics' Pilotless Aircraft Research for study of aërodynamic phenomena in the supersonic region.

Contemplated for the near future is the addition of a 6,100-acre range near the center of the peninsula. The growing requirements of ordnance stores caused by increasingly higher speed aircraft has necessitated an area for studying bomb trajectories under new conditions.

Another "range," though located upon station grounds, is the Test Cell. Here work proceeds, sometimes around the clock, on production testing of ammunition which is a job given special impetus by operational requirements and is an area where considerable intensification is expected.

With the use of these ranges in coordination with the Bureau of Ordnance contractors and technical liaison teams, test and development activity at NAOTS has steadily progressed. Now with improvements and enlargements on the way, this work is expected to push rapidly ahead.

It is in the area of development that the greatest strides are hoped for, especially in aviation weapons, fire control, and guided missiles. On an important scale, complete development work is already functioning on weapons and radar components.

And to extend this effort into related assignments, close collaboration with industrial and Navy know-how and experience is planned. At NAOTS that collaboration is being strongly cultivated to effect the maximum results from all its resources.

In the field of fire control this maximizing of effort includes direction of applied research toward the design, evaluation, and test of disturbed line of sight computers, horizontal toss and glide-bomb control and prediction systems, automatic and manual tracking systems, and antisubmarine radar ranging systems.

With the present Navy-wide emphasis on improvement of weapons and ammunition, a concerted effort is being directed on gun work. Several new types of guns are being designed and developed for evaluation and test. In addition, intense experimental and proof tests of ammunition are being conducted with further effort applied to modification of aircraft installations and instrumentation.

Ordnance Stores Tested

As an adjunct of weapons, experimentation and testing of aviation ordnance stores is progressing apace. Bombs, rockets, mines, pyrotechnics, and fuzes are undergoing constant development at the Naval Aviation Ordnance Test Station. The engineering of aërodynamically packaged equipment as typified by aircraft launcher pods is also emphasized.

In the broad area of guided missiles it is enough to say that checking, modification, and testing of various missiles is an important function of the station. This effort is matched by a program of personnel training for fleet utilization.

With the expansion and improvement of facilities has come a proportional increase in personnel. As at all research and development centers, a continuing effort is being made to locate and attract the most qualified people. To a large extent that effort has been successful.

Captain Bagdanovich is commanding officer of the U. S. Naval Aviation Ordnance Test Station and U. S. Naval Auxiliary Air Station, Chincoteague, Va.

Though separated from urban living, life at Chincoteague is never dull. The mild Virginia climate provides year-round opportunities for recreation, and for the sportsman, Chincoteague has a reputation particularly to be enjoyed. Flounder, bass, and ocean perch in plentiful quantities are just a few of the game fish that abound in the area. And in season, duck, deer, and small game are easy quarry in the large wooded tracts that line the shore.

For those who enjoy the social amenities there are continuous activities. In a relatively small station such as NAOTS, close working relationships develop into universal acquaintanceships that offer many opportunities for enjoyment—sharing the renowned Chincoteague oyster being but one! And then Washington, Philadelphia, Norfolk, and resort areas are but a few hours' drive away.

Coexistence with the Naval Auxiliary Air Station under one command, though rather unusual in itself, has proved in most instances quite successful. Under the command first of Captain Vieweg, then Capt. G. K. Fraser, and now my own, the association between the two organizations has become mutually important. To a great extent the Naval Aviation Ordnance Test Station relies upon the Naval Auxiliary Air Station for logistic support.

Facilities Shared

For the sake of economy, several service departments support both activities. The excellent airfield of one 8,000-foot and one 5,000-foot runway in existence and a third runway being extended to 8,000 feet is used by both stations. Messing, berthing, and medical care are also shared.

With international conditions as unsettled as they are and with scientific achievement growing mightily, it is requisite upon the Navy to maintain its high standards of readiness under all conditions. The development, test, and ultimate use of more lethal weapons to increase its striking power is a most significant part of the program.

The ZKW420 semiautomatic rifle.

Czech Military Small Arms

The Russian Influence Is Noted in Some Recent Weapons

Harry Wandrus

THE new army of the Czech republic created in 1918 was constituted of three main groups; the legionnaires returning from France, Italy, and Russia; the returning soldiers of the Austrian Army; and various volunteers from the civil population. It was because of this unique situation that the troops were found armed with British, French, Italian, German, Austrian, Russian, and strangely enough, some American small arms.

Austrian Arms

Despite the strong French influence in matters of staff, uniform, armored vehicles, etc., and the German influence in later designs, the Czech Army did maintain to a great extent the various Austrian Army small arms, most probably because of their abundance and because the men who were in charge were most familiar with them.

The troops were armed with model 95 Steyr rifles and carbines in 8-mm. Mannlicher caliber, with Steyr-Hahn pistols, the model 1905 cavalry sword, and the Schwarzlose machine gun. The machine gun had been manufactured to some extent by the engineering firm of Janacek in Prague and was maintained in the 8-mm. Mannlicher caliber until the 8-mm. Mauser caliber was adopted.

In the model V.Z. 7/24, the Czechs utilized the greater part of the earlier model, rechambering and rebarreling it for the newer caliber. Although replaced with the Z.B. 26, the Schwarzlose was still considered in official use in 1929, and specimens are seen there in secondary capacity to the present date.

No Precedents

Since the army started out with no precedents to follow and with an active energetic leadership fully equipped with great industrial potential, the government early decided to adopt new weapons and calibers.

In 1921 a goodly supply of Mauser parts was obtained from the Mauser works at Oberndorf, and these were built into rifles. The earliest Czech rifle was the model 98/22, very little more than an assembled piece.

Just a couple of years later they came out with what is still the basic rifle of the army, police, militia, and border guards—the V.Z. 1924. This rifle is in 7.92 caliber, has an over-all length of 43.3 inches, a weight of 8.6 pounds, and a practical range of 2,000 meters.

In 1938 the Czechs had ready 1,200,000 rifles of which the V.Z. 1924 constituted the greater number. While this rifle was of extremely good manufacture it had no exceptional features which would make it more desirable than comparable German or other Mauser rifles. It was made at Brno and very possibly at a number of other places.

A rifle, or rather carbine, which did have unusual qualities was the V.Z. 33, also in 8-mm. Mauser. Strangely enough it was issued only to the Czech police, but after the Germans took over in 1938 it, and its counterpart the G 33/40, were issued to paratroopers, mountain troops, service troops, etc. Manufactured at Brno, it had the features of being very light, short, and handy. Its over-all length was 39.4 inches, and it weighed 7.6 pounds.

German Influence

While German influence in rifle manufacture was noticeable, it was much more so in both machine guns and pistols. The Model 1923 pistol was in all probability of German origin and has been found with German Mauser markings. This pistol was the predecessor of the M1924 Czech army pistol from which all indications seem to point it was copied.

Conjecture has it that this pistol, along with several other models, was of German design and that the German plan to manufacture these was cut short by the Armistice and the Versailles Treaty which imposed restrictions on armament manufacture.

The Model 1924 is a locked-action piece with rotating barrel and light

Mr. Wandrus is a well-known student of small arms and ammunition. He is now firearms editor of *Hobbies* magazine.

recoil spring. This latter feature resulted in very poor firing or reloading reliability and with poor ammunition (sometimes even with the best) malfunctions in loading were common.

While extremely well made, it was not too reliable and was a lot of mechanism for the rather insufficient .380 cartridge. This arm saw use as one of the official army sidearms, but was gradually replaced by the Model 1927.

Similar to Mauser

The Model 1927 also showed considerable German influence, and much of it is similar to the Mauser Model 1910. In general appearance it looks much like the M.1924, but is instead a simple blowback action using a much smaller but almost as effective cartridge, the .32 ACP. This pistol has weathered the various political changes and is still the official sidearm.

Many of these were produced for the Germans during the war and an eyewitness has stated that the assembly lines hesitated, but did not stop when the Germans left the country. The bosses and serial numbers changed, but the pistols kept coming off the same lines.

The Czechs are never happier than when they can produce a few armament monstrosities. Such a one was the Model 1938DA or CZ37 semiautomatic pistol, more often referred to as the Strakonitz 1938, after the city of manufacture. In this military pistol the Czechs did incorporate a double-action feature which was ostensibly included so that the arm would be handy for the cavalryman.

Poor Design

It was possible to load this pistol by pulling back the slide, thus chambering a cartridge. The hammer followed the slide back to its rest position, and since it was made without any serrations it was not possible to cock the pistol other than by pulling on the trigger. This double-action feature made for extremely poor shooting, and even an expert with many hours' practice has difficulty doing anything worthwhile with it.

Why the Czechs persisted in wasting their efforts with the .380 cartridge which is little better than the .32 is yet to be understood. The 1938DA has gone the way of the M1924—both of which never had much reason for existence anyway.

In addition to their use of the Schwarzlose, the Czechs manufactured and are possibly still manufacturing one of the Skoda Maxim machine guns. Examples of these appeared in Greece as late as 1950, and it is quite possible that they were of fairly recent manufacture.

These guns were also a heritage of the Versailles Treaty which forced the Germans to relinquish many of the completed guns and parts to the Czechs, among others.

Suited the Germans

When the Germans seized the country in 1938 they came upon thousands of these which they used as aircraft and infantry weapons and continued the manufacture of more. In 7.92 Mauser caliber they were aptly suited to the Germans.

Probably the most celebrated of Czech weapons is what is most commonly designated the Bren gun or Z.B. 26. Invented by Vaclav Holek, a worker in the Zbrojovka plant at Brno, it made him a wealthy man and spread far and wide the fame of the Brno Small Arms Works. Made in quantity for Ethiopia and Jugoslavia and under license by the British and Canadians, it was also sold to the Chinese Nationalists.

Specimens bearing Chinese markings have been taken from the Chinese Reds, and when one considers the conditions of warfare which have been almost continuous in China and the fact that these arms have been in service since before 1938, it is something of a tribute to the workmanship found in them.

A gas-operated arm, the Z.B. 26 is still manufactured by the Czechs in 7.92-mm. caliber, has a cyclic rate of fire of 550 rounds a minute, but is most suitably fired for prolonged periods at the rate of 180 rounds a minute.

The Czech ZK383 submachine gun.

This weapon, on which the first work was done way back in the early 1920's, is still considered among the finest of the light machine guns and the many modifications and improvements have only served to strengthen that impression.

In 1937 Holek came forward with a heavy machine gun embracing many of the principles of the Z.B. 26 but having certain different physical characteristics. As manufactured by the Czechs at Brno it is in 7.92-mm. caliber with a rate of fire of 550 rounds a minute or an accelerated rate of fire of 750 rounds.

Variety of Models

It appeared in a variety of models of British, Czech, and Canadian manufacture and always in 7.92 caliber—except for some of the variations like the ZB-60 which appeared as the model of 1938 in 15-mm. caliber. Equipped with tripod, wheels, or other mounts and longer barrel it could be used for antiaircraft and antitank purposes.

The Czech ZH-29 semiautomatic rifle.

An invention of one of the other Holek brothers, Emanuel, was the Z.H. or Z.B. 29 semiautomatic rifle. In addition to its use by the Czech Army it

saw considerable export to other countries including Ethiopia. Using the standard 7.92-mm. cartridge, this arm was semiautomatic only, was gas-operated, weighed 11 pounds, and was equipped with magazines of 5-, 10-, or 20-shot capacity.

This arm saw considerable use by the Germans who used all the Czech Army had. Some specimens have been noted in Russia—obtained either through trade or capture from the Germans.

Large Arms Source

The German acquisition of Czech arms plants meant for them an unusually large immediate and potential arms source. In the years following the occupation they enlarged those already in operation and opened others in Slovakia. By the time the war was over these plants were supplying the German Army with fifty per cent of its small arms.

The Germans continued the manufacture of the Maxim machine guns, the V.Z. 24 rifles, the V.Z. carbines, the Model 1927 pistols, and possibly the Bren gun to some extent.

There seems to be little evidence that they did much with the other pistols, though a few of the M1924's have been found with German inscriptions and proofs.

The ZH-29 was not continued but the ZB-26 may have been in some small degree along with the Besa or MG-37. These weapons met the requirements of having a caliber in common with the German but too often of not fitting into the over-all weapons picture. Still, one wonders whether it might not have been better to have used the machinery on hand rather than to retool for new types.

A decision was made before the war was over and formally announced on May 20, 1945, that the future Czech Army was to be equipped after the fashion of the Russian Army. However, this was easier said than done, and it was some years before anything of any consequence in this direction occurred.

As late as 1951 new Czech designs appeared, and it is only recently that Russian-type arms have received any note in the new army. For the most part the weapons in general use are much the same as those in use before the war—this again because of their abundance and the high cost of changing over to new weapons. A great many new designs have appeared nonetheless, and undoubtedly some of these are finding their place in the country's forces.

Plans were made in 1945 eventually to equip the entire army with the ZKW 420 semiautomatic rifle, a successor to the famous prewar ZB-29. This weapon is of more rugged construction and is much more reliable and slightly lighter. In general it has external lines not unlike those of the Garand.

Gas-operated, its over-all length is 41.34 inches, and it weighs 10.5 pounds. It was tested by the Russians, but what they ever decided is unknown. In all probability it struck them as being much too involved or too expensive for mass production.

The ZK383

While released as a new model, the ZK383 submachine gun made by Brno and introduced in 1950 was in reality little more than the prewar V.Z. 9 or Model 1939 which saw use in the Czech Army and later in the German. Some numbers of these were captured from the latter. The gun is not too adaptable to mass production because of the many machined parts.

It has 2 rates of fire, 500 or 700 rounds a minute, the rate being controlled by a removable weight. The army model has a detachable barrel and bipod while the ZK383P police model has a nondetachable barrel and no bipod.

To what extent these are still being used or manufactured is unknown, but as late as 1950 they were an export item and were being sold to various armies, including those of non-Communist countries.

Why a country cannot be satisfied with one submachine gun is a question never asked by Czech designers who apparently have designed some three or four since the end of the war. The CZ47 was introduced in 1950-1951 and was designed and manufactured at Strakonice, which is usually more concerned with the manufacture of pistols. In 9-mm. Luger caliber like the ZK383, this weapon employs the blow-back principle for actuation.

Its most unusual feature is the magazine which can be swung around for firing in either the vertical or the horizontal position. This feature should make for great ease in firing in different situations where the magazine position would be important.

The trigger pull is arranged in two stages so that single shots can be fired on the first pressure and continuous fire by continued pressure. Over-all length of this piece is 30.9 inches, magazine capacity is 40 rounds, and the rate of fire is 560 rounds a minute.

Several other submachine-gun models have been heard of, notably the models 23 and 48, but little is known of these. They are designated with S or ss numbers instead of the former VZ classification. One of these uses a Schmeisser-type tubular breechblock in which the various parts of the bolt telescope into each other.

These weapons show strong Russian influence in design and manufacture—most significantly in the 7.62-mm. pistol ammunition of Russian type.

One refreshing bit of arms design appeared in 1950 in an export model pistol designated with the unexplained model number of .006. Unlike the rather strange twists of Czech designs in other weapons, this pistol had very much to commend it.

Russian Attitude

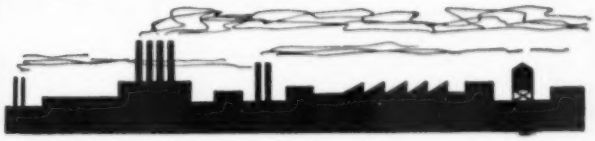
The Czech arms manufacturers have always had a reputation for excellent workmanship, but the Russian attitude as regards weapons of war is to make them as simply, easily, and cheaply as possible.

The lessening of quality of manufacture and the increasing simplicity of most Czech military small arms would seem to indicate the ever-present Russian, and it is to be expected that all future Czech designs will be of rougher workmanship.

Reg. U. S. Pat. Off.

INDUSTRIAL PREPAREDNESS

a monthly report on current scientific and logistical developments as they relate to the national defense



AMERICAN ORDNANCE ASSOCIATION • *Founded in 1919* • 705 MILLS BUILDING, WASHINGTON, D. C.

No. 85 November 1953

● **The Defense Department** obligated $28.6 billion for the purchase of major equipment and supplies, military construction, and expansion of military production facilities during the fiscal year which ended June 30th.

Of this amount the Army obligated $6.5 billion, the Navy $7.8 billion, the Air Force $14.2 billion, and $0.1 billion went for interdepartmental construction.

Obligations for procurement of "hard goods" (aircraft, ships, tanks, weapons, ammunition, production equipment, electronic equipment, electronics, and other equipment) amounted to $23.3 billion, with "soft-goods" procurement and obligations (clothing, subsistence, and petroleum) aggregating $3 billion and construction $2.3 billion. Procurement obligations for military-assistance programs accounted for $2.1 billion of the $23.3 billion obligated for "hard goods."

Total Department of Defense obligations for the fiscal year 1953, including military pay and allowances, research and development, and other activities, as well as procurement and construction funds, were approximately $46.5 billion.

● **Defense Mobilizer Flemming** said he would announce the Government's official policy on machine tools shortly. The new policy will be aimed at keeping intact "packages" of machine tools located in tank-producing and other defense plants which are scheduled to close down. Mr. Flemming also disclosed the Defense Department is drawing up a list of "obsolete" tools it plans to dispose of.

● **A battalion** of 280-mm. mobile guns, the Army's latest and largest field-artillery weapons, will shortly be deployed to Europe for use in support of the NATO defense forces under General Gruenther.

In making this announcement Army Secretary Robert T. Stevens named the 868th Field Artillery Battalion, Fort Bragg, N. C., as the first of several 280-mm. battalions planned for deployment to Europe. These battalions will be assigned to United States units already in Europe. Mr. Stevens stated that the shipment of these battalions has been in the planning stage a long time and is part of established United States policy to make available for the support of the NATO coalition highly trained and well-equipped balanced forces.

The weapon has a relatively high degree of mobility, long range, and a high order of general effectiveness with conventional high-explosive ammunition. These characteristics will prove a useful augmentation in support of defense forces being built in Europe. The 280-mm. gun is also capable of firing atomic ammunition.

"No single weapon will solve the military problems of Western defense or deter aggression," Secretary Stevens stated as he pointed out that although the 280-mm. gun strengthens the defense shield of NATO it cannot be regarded as a substitute for other weapons and forces that are required for the defense of Europe.

The 868th Field Artillery Battalion, now finishing its training at Fort Bragg, will be stationed in western Germany where it will train and maneuver with NATO forces. It and similar battalions which will join NATO later will be placed at the disposition of the Supreme Allied Commander, Europe.

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● **Assistant Secretary of Defense C. S. Thomas,** former Under Secretary of the Navy, has transmitted to Congress the semiannual report on the stockpiling program covering the period from January 1 to June 30, 1953.

In his letter of transmittal Secretary Thomas said: "During the reporting period, the responsibility for the stockpiling program was transferred from the Munitions Board to the Office of Defense Mobilization under the authority of Reorganization Plan No. 3 which became effective on June 12, 1953.

"Since responsibility for the program reposed in the Munitions Board for the major portion of the reporting period, this report has been prepared by the office pursuant to an agreement to that effect with the Office of Defense Mobilization. The Munitions Board was abolished on June 29, 1953, as a unit of the Office of the Secretary of Defense, and its former responsibilities are now those of the undersigned."

This is a report of progress in the stockpiling of strategic and critical materials and stockpile-supporting activities for the period of January-June 1953.

Primary responsibility for stockpiling was transferred from the Munitions Board to the Office of Defense Mobilization during June. By agreement, this report is being submitted by the Office of the Secretary of Defense through the Assistant Secretary for Supply and Logistics.

Strategic and critical materials in the stockpile, as of June 30, 1953, were valued at $4,184,307,550 on the basis of current prices. In addition, materials valued at $1,469,101,166 were under contract and scheduled for future delivery as of the same date.

The total value of stockpile objectives, at current prices, amounts to $7,167,084,716. The value of materials in inventory and under contract therefore represents 79 per cent of the total dollar value of the program.

Materials delivered to the stockpile during the period were valued at $421,462,950. Most notable improvement was in delivery of bulk tonnage materials.

Government-owned surplus materials valued at approximately $2,115,000 were delivered to the stockpile during the period.

Reviews of 21 materials were completed during the period. Lower objectives were established for 8 of the materials reviewed. Selenium was added to the stockpile list and purchase program.

Purchase specifications for 18 materials were revised. Major changes were made in the specifications for manganese, mercury, and mica.

The review of stockpiling policy was completed.

Results of the review were incorporated in a manual concurred in by all Government agencies having stockpile responsibilities.

The stockpile warehouse construction program is proceeding rapidly, and shipments for storage are being made as units are completed. However, a shortage in excess of 4 million square feet of approved-type space will remain to complete the objectives of the program.

The stockpile being accumulated under Public Law 520, Seventy-ninth Congress, is the Nation's reserve of selected materials designed to make up the deficit between probable supplies and estimated total needs during an all-out war. It is national in scope—not just military. Its purpose is to provide for the industrial and essential civilian needs as well as those of a direct military nature. The primary objective of the Stockpiling Act is to reduce, and eliminate if possible, a dangerous and costly wartime dependence upon foreign sources of essential raw materials. Hence the materials stockpiled are principally those which come wholly, or in substantial part, from foreign sources, rather than those which can be produced in this country in sufficient amounts to meet essential wartime needs.

● **Rapid advances in guided missiles** have been made during the tenure of K. T. Keller as director of development of those weapons in the Office of the Secretary of Defense.

Secretary Charles E. Wilson recently announced the completion of the assignment of Mr. Keller who will return to the chairmanship of the board of Chrysler Corporation and other private interests.

Mr. Keller recommended in June to President Eisenhower and Mr. Wilson the dissolution of his office "in view of the present advanced state of guided-missile development."

"With several guided missiles already in production, others relatively far advanced through the evaluation phase, and some in the early stages of research, it is advisable at this time to channel the activities of the Office of Guided Missiles into the regular administrative and planning organs of the Department of Defense," Mr. Keller said.

Mr. Keller, at the request of former President Truman, came to the Pentagon in August 1950 to coördinate the services' guided-missile planning. At that time the services were largely going their independent ways in developing guided missiles, and many of them were in competition with each other.

Beside providing the Secretary with advice for proper direction and coördination of research and development of guided missiles, Mr. Keller also acted as guided-missiles consultant to the old Research and Development and Munitions Boards which were abolished under the reorganization act approved by the last Congress.

● **There are hundreds** of assorted can openers on the market today—but none like the one the Army wields at the Lima Ordnance depot.

This unique can opener actually is a crane whose boom is equipped with tentacles. It is used to lift lids off cans—some of which measure 55 feet in diameter. The enormous containers—which look like oil tanks —stand 11 feet high. They are part of the Army's long-range storage system for tanks and other "canned" armored equipment.

The canned-armor plan paid off when hostilities broke out in Korea. All the Army had to do was apply its can opener and there, in a perfect state of preservation, was a variety of armored might virtually ready for shipment to the combat area.

Only 50 to 60 man-hours were required to clean up the vehicles and remove the surprisingly little preserving compound applied when they were stored years earlier.

Secret of the canning process is the hermetically sealed cans equipped with an automatic dehumidification system which keeps the average daily moisture content at a level of 30 per cent or below.

● **Dr. John E. Vance,** head of the Department of Chemistry at Washington Square College of New York University, has been named Deputy Chief of Research and Development and Chief Scientist of the Department of the Army. He succeeds Dr. Harold V. Gaskill, who has returned to his duties as dean of science, Iowa State College, after a year's leave of absence.

Dr. Vance, a native of Dayton, Ohio, holds degrees from Yale University and taught there from 1929 until World War II. A major in the Chemical Warfare Service and later a lieutenant colonel in the Corps of Engineers, Dr. Vance worked on the Manhattan Project from November 1943 until August 1946, when he returned to his teaching duties at Yale.

In 1947 he served with the State Department under Frederick H. Osborn, deputy representative to the UN Atomic Energy Commission, to prepare the

FUTURE SCHEDULED MEETINGS OF NATIONAL TECHNICAL DIVISIONS AND SPECIAL COMMITTEES OF THE AMERICAN ORDNANCE ASSOCIATION

- **Metal Lubricants Committee at Dayton, Ohio, October 28, 1953, and at Cincinnati, Ohio, October 29, 1953.**
- **Rocket Committee of the Rocket, Bomb and Artillery Ammunition Division at Redstone Arsenal, Huntsville, Ala., November 5-6, 1953.**
- **Gage Industry Division, January 1954.**

second UN-AEC report covering technical aspects of the international control of atomic energy.

● **The Army's "Detroit on the Isar"** has been turned into a Bavarian Willow Run to produce thousands of tank, jeep, and truck engines and power-train assemblies.

It is the largest tank-automotive rebuild shop in the world. Located between Munich and Dachau, the Karlsfeld Ordnance Depot—as it is known officially—occupies a fenced-in area of 273 acres, 243 of which are in operational use for supply, storage, and industrial operations.

Prior to its capture by American soldiers in 1945, the plant turned out an average of 600 aircraft engines each month for the German Air Force.

Today, under direction of 25 Army officers, 19 enlisted men, and 25 civilian technicians, the plant supplies the Army's European Command with thousands of engine and power-train units rebuilt and assembled by 6,000 German nationals, displaced persons, and refugees.

Indicative of the activity at the Bavarian Willow Run are records which show that over a 6-year period more than 135,000 rebuilt engines came off the plant's assembly line.

The savings in dollars is tremendous. In the reclamation branch alone, a saving of $740,000 was realized over an 8-month period. Records show that for $1.60 the plant can reclaim a jeep cylinder block that would cost $127.34 new. For $6.50 it reclaims jeep crankshafts priced new at $24.57.

Success of the Karlsfeld Ordnance Depot as a major rebuild center is due primarily to two accomplishments:

1. Adoption of mass-production methods for complete rebuilding of all types of Army engine and power-train units;

2. Education of the Western German manufacturers to mass-produce spare parts with U.S. dimensions, threads, and, in many cases, U.S. material specifications.

● **In a move to "modernize" military financial and accounting procedures,** Defense Secretary Charles E. Wilson named a 12-man committee to work out "a more effective, simplified, standardized" system for financial management.

Headed by Charles P. Cooper, former vice-president and director of the American Telephone & Telegraph Company, the group includes Assistant Secretaries of Defense W. J. McNeil and Charles S. Thomas and 9 business executives.

The other members are: Albert Bradley, executive vice-president of General Motors; W. Harold Brenton, president of the American Bankers Association; Paul M. Green, dean of the College of Commerce and Business Administration at the University of Illinois; Robert E. Gross, president of the Lockheed Aircraft Corporation;

Also, Joseph B. Hall, president of the Kroger Company; D. L. Millham, vice-president of General Electric; Frank H. Neely, chairman of Rich's, Inc., Atlanta, Ga.; Robert L. Stearns, president of the Boettcher Foundation; and E. M. Voorhees, chairman of the finance committee of United States Steel.

Secretary Wilson explained that the collection of expenditure data within the services "is not in line with their responsibilities" and that "while they have been making progress in this area" they are "generally agreed" on the need for a more modernized system.

Following the first meeting of the new committee, designated the Advisory Committee on Fiscal Organization and Procedures, Chairman Cooper and the group hope to come up with some recommendations "that will promote better results in the management of the Defense Department."

He noted, however, that the present difficulties of the military accounting system do not stem "from lack of regard of the people in the establishment" but have developed as a result of the rapid growth of the Department.

The Committee will meet periodically to review staff studies in various fields of fiscal management and to make recommendations to Secretary Wilson. These recommendations, Mr. Wilson said, probably will be put into effect on a piecemeal basis as they are received and approved.

Admiral Arthur W. Radford, United States Navy

Chairman of the Joint Chiefs of Staff

Will be the honor guest and

principal speaker

at the

Annual Industrial Preparedness Dinner

of the

American Ordnance Association

to be held under the auspices of

The New York Post

in the

Grand Ballroom of the Waldorf-Astoria

New York City

Wednesday, December 2, 1953, at 7:30 P.M.

The Association's Blandy Gold Medal for distinguished service will be awarded to Admiral Radford.

Reservations for the dinner will be accepted until Wednesday, November 18, 1953, if seating space at the Waldorf still permits. Any surplus of receipts over expenditures connected with the meeting will be donated to The Navy Relief Society.

Black tie *Guests may be brought*

Month by Month: Highlights of the National Defense

Director of Guided Missiles

When Mr. K. T. Keller completed, on September 17, 1953, his assignment as Director of Guided Missiles in the Office of the Secretary of Defense, he added another significant milestone in the distinguished career of an outstanding industrial leader.

"With several guided missiles already in production, others relatively far advanced through the evaluation phase, and some in the early stages of research," Mr. Keller said, "it is advisable at this time to channel the activities of the Office of Guided Missiles into the regular administrative and planning organs of the Department of Defense."

Asked by former President Truman to coördinate guided missiles planning activity for the Department of Defense, Mr. Keller was named Director of Guided Missiles by Secretary of Defense George C. Marshall in October 1950.

In addition to providing the Secretary of Defense with advice for the proper direction and coördination of research, development, and production of guided missiles, Mr. Keller also acted as consultant to the Chairman of the former Research and Development Board and the former Munitions Board in the guided-missiles field.

Mr. Keller's niche in our military history was first won by his great aid to Army and Navy Ordnance during World War II. In the vital field of tank design and production in that conflict he began for his company—the Chrysler Corporation, of which he is board chairman—an enviable tradition which was continued by the corporation in the Korean War. He was an adviser to Lieut. Gen. L. H. Campbell, Army Chief of Ordnance in World War II.

A director of the American Ordnance Association, Mr. Keller will continue as chairman of the board of the Chrysler Corporation.

His many friends in the land, sea, and air arms of the Defense Establishment and throughout industry will join in this salutation to him for another defense assignment cheerfully undertaken, painstakingly developed, and patriotically fulfilled.

New Defense Team

The newly authorized nine Assistant Secretaries of Defense are now operating as a team.

It appears that their main function will be to run interference for the man carrying the ball. Their job is to help the operating agencies and not to hinder. They will direct and not operate; cut red tape and not create it. Such functions at the top, rigidly adhered to, are just what the doctor ordered for an ailing, overweight, garrulous defense organization.

The nine competent men were appointed to their present positions by President Eisenhower in his reorganization of the Department of Defense that was intended to concentrate and centralize more power in Secretary of Defense Wilson.

Statutory boards and staff agencies were abolished, and their powers were vested in the Secretary of Defense who promptly allocated these functions to his nine vigorous assistants—"the nine vice-presidents" as they are called in defense circles.

It is Secretary Wilson's desire that these men set policies and assist the various branches of the armed services in carrying out their responsibilities.

The new streamlined Department of Defense will not engage in operations but will call the signals in a strictly policy-making rôle. Experts are in agreement that the new organizational plan resembles very closely the organization of General Motors, formerly headed by Secretary Wilson.

In the big, efficient GM organization, vice-presidents head sections organized along functional lines that establish general principles, but do not interfere with the operation of member companies.

If one of the member companies has sales trouble, for example, he can go to the vice-president in charge of sales and get the kind of top-rank assistance he needs.

Thus far the new team of Assistant Secretaries is doing a creditable job as coördinators and trouble shooters for the various branches and bureaus of the armed services.

May they continue to cut across lines of authority and replace the concept of "command" in the Pentagon with that of "help" and substitute coöperation for interference.

Admiral Radford and Economy

Good news for hard-pressed taxpayers! Adm. Arthur W. Radford, new Chairman of the Joint Chiefs of Staff, expressed the view that the Nation should get more military effectiveness for its money than it has been getting.

He declared that the Nation has reached the painful stage where it must eliminate the waste and duplication which resulted from the hasty build-up of the armed forces after the sudden and unexpected outbreak of the Korean War in 1950.

Admiral Radford declined to say, however, whether this would mean any reduction in military spending from the $42.3 billion rate forecast for the present fiscal year that ends next June 30th.

The Joint Chiefs of Staff are currently engaged in a critical review of the Nation's war plans as well as the personnel and munitions needed to support them.

Present goals call for an Army of 20 well-equipped divisions and a National Guard of 27 divisions by the

end of 1954, a Navy of more than 400 combat ships, 9,900 operating aircraft, and 3 Marine divisions by the end of 1954, and an Air Force which will consist of 120 modern wings by the end of 1955, together with an additional 22 wings in Reserve and Air National Guard units.

Admiral Radford said he believes the Nation is presently in a "down" period as far as national spirit and confidence in leaders is concerned. He blamed this, in large part, for the difficulty the services face in acquiring and keeping highly trained and experienced personnel.

Next to matériel and budgetary problems, he indicated the problem of personnel is the toughest one the services face today.

Modern Air Power

In the face of growing concern in some quarters, three top officials recently expressed satisfaction with the progress being made in national defense—particularly in the field of air power.

Roger M. Kyes, Deputy Secretary of Defense, said that the secretaries of the military departments and their chiefs of staff are studying ways and means to achieve better organization within their respective services.

> *"Through the coöperative effort of the military and civilians," he declared, "much more progress is being made toward the improvement of our defense establishment than is apparent to the casual observer."*

Assistant Secretary of the Air Force for Matériel Roger Lewis asserted that the ability of the Air Force to devote itself with unflagging purpose to carrying out its mission will succeed only to the degree that the American people understand that predominant air power is indivisible from our national security and world peace.

Assistant Secretary of the Navy for Air James H. Smith, Jr., pointed out that the striking power of today's Navy is many times that which was found so valuable in World War II.

Mr. Smith traced the Navy's air progress in a variety of ways. In point of speed he asserted that 450 miles an hour was a respectable speed for fighter aircraft in World War II. Today, however, talk of tripling that speed is commonplace. The Douglas Skyrocket, for example, has flown 1,239 miles an hour.

> *"Improved radar," he said, "has extended the pilot's vision far beyond nature's gift. By improved communications the pilot's response to intelligence or command has been extended.*

"In modern air-to-air combat, ground radar 'sees' the distant planes, both enemy and friendly. Through electronic communications the controller directs his fighters to the interception. By radar the pilot 'sees' his opponent and completes his contact for combat.

"Then electronic fire-control systems come into action. Meanwhile, in many planes, an ever-watchful radar eye is alert to warn the pilot of any enemy who tries to attack from behind."

Two Golden Anniversaries

Thus far in this fateful year of 1953 two anniversaries of outstanding significance in the annals of our national defense have passed by with practically no reference in the public press. Yet both are of major significance to the national defense.

This year marks the fiftieth anniversary of the adoption of the famed Springfield Rifle, Model 1903, which for more than a third of a century was the standard rifle of the American Army, Navy, and Marine Corps.

And in the same year the then Secretary of War, the Hon. Elihu Root, whose stature as an American statesman grows with the years, established the General Staff of the United States Army. The two have played important rôles in our Nation's record in the twentieth century.

The Springfield has been superseded by its faster-firing successor, the Garand. The Staff has grown in strength and fulfills its important mission with alacrity. It has accomplished much good in the coördination of our military might, although it is by no means the small strategy-making group Mr. Root had in mind when he conceived it fifty years ago.

Both anniversaries provide food for thought for in both are recorded, implicitly and explicitly, successes and failures of prime importance. If we are wise we will read those records, for their imprint on the past fifty years is of vital meaning to our military prowess in the Atomic Age.

The Springfield Rifle, Model 1903, was the outcome of constant striving for increased firepower and accuracy for the American fighting man—a striving which must be carried on with the vigor, acumen, and pride so noteworthy throughout our long Ordnance history.

The American Civil War had scarcely ended when in 1866 the caliber .58 muzzle-loaders were converted into breech-loading rifles as designed by E. S. Allen. Seven years later, the single-shot caliber .45 rifle, also known as the Springfield, was adopted by the Army. It remained the standard for the next two decades until, after ceaseless experiments, the caliber .30 magazine rifle, known as the Krag-Jorgensen, of foreign origin as have been so many of our basic arms, became the Army standard. That was in 1892.

> *In 1903, the U. S. Rifle, Caliber .30, Model of 1903,* THE *"Springfield" of imperishable memory, came upon the stage to hold undisputed eminence and, during World War I, to win the hearts of American fighting men as well as of expert riflemen in civil life.*

It was a sad day for many an infantryman when, on the eve of World War II, the semiautomatic, with its tremendously increased firepower, replaced the Springfield. Our soldiers were then still trained riflemen who depended on the accuracy of the single shot, and they belabored the soldier who required a second shot to get his enemy. Another complaint was the greatly increased demand for ammunition made necessary by the new rifle, or at least made necessary by untrained riflemen.

Many an expert riflemen of a decade past will tell you that marksmanship in our fighting services today is not as good as it should be and used to be; that training in marksmanship does

not receive nearly the emphasis adequate to the needs of the times; and that the consumption of small-arms ammunition, as a result of automatic and semiautomatic fire without adequate appraisal of marksmanship training, is a sign of decadence as well as an unnecessary increase in the cost of defense.

Be those considerations as they may, and there is more than the old soldier's complaint in them by a long shot, the Springfield, Model 1903, was, and still is, a great rifle.

Its long and glorious history is a bright page in American Ordnance progress, reflecting great credit upon the Ordnance Department of the Army and the Springfield Armory, as well as on that stalwart band of Army Ordnance officers who contributed so unselfishly through the years to making the Springfield an ever better rifle.

That goes for industry, too, which had an important share in the achievement.

In this fiftieth anniversary year let us pay homage to the men who made the Springfield as well as to those who used it effectively in battle. Both are worthy, as is the Springfield, Model 1903, of our thanks, our praise, and our admiration.

The fiftieth birthday of the Army General Staff is likewise a time for review, in the light of the record, for it is a record of achievement in line with the evolution of command of huge land forces, such as characterized the great armies of Europe—notably the French and German, and, with lesser acclaim, those of England and Russia.

Mr. Root's superb contribution to America's military achievement has been acclaimed as having brought to the Army what the task-force idea has meant for the Navy—and the modified staff for the Air Force—each idea and method being best adapted to the mission of the medium involved.

The General Staff of the United States Army, under the direction of some of the greatest military leaders in our history, has crystallized strategy so that the hotchpotch control of the era prior to 1903 has been welded into a unified operation.

In the nature of things this was made necessary by the sheer size and complexity of the military tasks which confronted our fighting forces in France in World War I and in Africa, France, Italy, Germany, the Pacific, and Japan in World War II, and in Korea in that strangest of all our conflicts—the Korean War of 1950-1953.

As we read Mr. Root's intentions and attitudes regarding the formation of an Army General Staff, he had in mind the two prime purposes which the very term connotes: the determination of military strategy to effectuate national policy as set by the civilian leadership of the legislative and administrative branches of Government, and, as a corollary of over-all strategy, to determine the requirements in men and munitions to make that strategy successful.

Those are duties of the gravest importance, and they require the most sagacious, experienced, and intellectually honest military leaders within call.

Mr. Root's ideals in these respects have been met with glowing success.

Our military strategy in the wars in which we have been engaged since 1903 has been far more creditable than has our political strategy. It was not our military leadership in 1914 that raised the slogan "Too Proud To Fight."

Our Chiefs of Staff fought against insuperable odds during the tragic 1930's to keep the semblance of a skeleton army when political leadership would have little of it.

It was not our military strategists in the 1940-1945 period who demanded "unconditional surrender," nor did they invent the Morganthau Plan for dealing with the enemy.

One has but to recall the words and actions of General MacArthur to know that again in the Korean War the political and not the military strategists were in control—and to our national sorrow and dismay.

The record as to the computation of requirements of munitions is not a glowing one. Too often allocations have been ethereal rather than real; too frequently they have been too late rather than too soon. Most serious of all has been the ever-widening orbit of operations in the technical field of design and production by what should be most strictly a policy-making and not an operating agency.

These reflections are not meant in the slightest to offset the real worth of the record of the Army General Staff during fifty years. They are indications nevertheless that the evolution of ever-increasing efficiency and economy may yet bring about in still higher degree the ideas and the ideals of Elihu Root —statesman, patriot, and keen observer of the human beings by whom wars are made and won—or lost.

Lower Insurance Rates

Special Financial Services Division, Office of the Chief of Finance, reports that through the continued efforts of its Contract Insurance Branch a reduction of thirty-five per cent on workmen's compensation insurance rates for Department of Defense explosive manufacturing contracts has been successfully negotiated with the Conference Committee on the National Defense Projects Rating Plan.

The reduction became effective on new, renewal, and outstanding policies as of July 15th.

Loss experience on presently operating explosive risks was accumulated in the Contract Insurance Branch for the years 1950-1952, showing approximately a twenty per cent average loss ratio.

Since standard premium charges generally are based upon a permissible sixty per cent loss ratio, this phenomenally favorable and consistent experience formed a realistic basis upon which to negotiate for lower rates.

There are some fifteen large explosives manufacturing plants on which the Government will benefit through reduced premium reimbursements.

On a single risk producing, for example, a previous annual standard premium of $500,000, this rate decrease will result in a standard premium reduction of $175,000.

Ordnance Esprit

An Editorial

MAJ. GEORGE FIELDING ELIOT, in a recent issue of this magazine, wrote a thought-provoking and most timely article entitled "Has the Army Lost Its Soul?". Few articles in these pages have created greater reader interest or more general approval.

His plea was for a return of the morale of the small unit — a rekindling of the regimental fire which in days gone by inspired men to fight and die for their regiment as well as for the army of which it was a part and in turn for the nation the army and groups of armies were formed to defend. The *esprit* of the Industry-Ordnance team is worthy of reflection in this regard.

Think for a moment of our great national institutions that have survived the test of time and are eminently worthy of our admiration and esteem. Group pride is an immensely valuable asset in all walks of life.

A man or woman or child can and should take a legitimate pride in the family name and history, and in the home, with all its enduring memories and fond associations. The old school tie still signifies the finest kind of camaraderie. One's church links him with the eternal verities. The soldier should take pride in the tradition of his regiment.

Imitating the ancient Greeks in their devotion to the city-state, today's citizens should take pride in their communities and seek always to be worthy of their civic and national heritage.

The Ordnance Family

There are other equally deep loyalties—for example, the historic bonds of patriotic fellowship that have united the great Ordnance family since the foundation of our republic.

The Ordnance family extends around the world. It consists of all military, naval, and air personnel, active or retired, who work or once worked with weapons, be they commissioned or non-commissioned, young or old, living or dead.

The Ordnance family embraces scientists and engineers. It includes employers and employees of all the organizations, public and private, which design and produce the weapons of defense in time of peace for use in preventing war.

The Ordnance family is made up of the rank and file of citizens who, while not directly and presently affiliated with the Ordnance team as members of the American Ordnance Association, nevertheless, as patriotic Americans, are giving their support to a cause which is basic to the defense of our Nation in this atomic age.

The contemporary tendency is to overemphasize the achievements of science and technology and to minimize such transcendental values as loyalty, morale, and *esprit*. Too frequently men are treated as robots, as numbers, as objects, as abstractions. Human beings are referred to as "spaces," if you please!

Then we become alarmed about the spread of selfishness and the lack of interest in fundamental human relationships, whether in statecraft, science, education, religion, or military affairs!

In Men, Not in Things

The *esprit* of the Ordnance team is rooted in men and not in things. All of us recall with pride and deep gratitude the fruitful influence of Maj. Gen. William Crozier, of Maj. Gen. C. C. Williams, of Adm. W. H. P. Blandy, and Vice Adm. George F. Hussey, Jr., and the unconquerable spirit of General Arnold, General Kenney, and General Spaatz among the giants who built our Air Force. We will always take pride in the magnificent civilian accomplishments of such dedicated men as Benedict Crowell and James L. Walsh.

The Ordnance team has never known defeat. It has never tasted the bitterness of surrender. Generation after generation, new men have come upon the scene, valiant men, experienced men, prudent men. They have given the Nation the very best that was in them. Upon retirement, they passed on to their successors the traditions and high purposes of an essential national defense institution.

Ordnancemen will continue to guard the ramparts of freedom—loyal, competent, unafraid; nourished and sustained in their inmost souls by the memory of other watchmen who always put duty above self-interest; aided and encouraged by their associates who, like themselves, have pledged their honor and their lives in a sacred cause.

When George Fielding Eliot wrote in these pages he raised the question whether the Army, having become a huge and highly regimented bureaucracy, has not lost its soul. He emphasized the danger that lurks in trying to run an army on a "business basis." Men are not machines, and too much mechanical efficiency, as applied to human beings, may destroy the *esprit de corps* that is so essential to any good fighting unit.

The Ordnance fraternity has always realized that there is no substitute for *esprit*. It has always cultivated and fostered a sense of pride, a sense of belonging, a sense of personal responsibility, a sense of continuing accomplishment in arsenal and depot, in the Pentagon and on the battlefield. Ordnance has always known that a howitzer is only as good as the men who design, make, maintain, and fire it. Superior firepower, yesterday and today, originates in superior manpower.

May Ordnance *esprit* improve with the years. May Ordnance continue to set an untarnished example of fraternity, devotion to duty, competence, and unswerving loyalty to those human and divine ideals which are the priceless and immortal heritage of free men everywhere.

ASSOCIATION AFFAIRS

National Executive Committee Forms New A.O.A. Technical Divisions

A meeting of the Executive Committee of the American Ordnance Association was held at the Metropolitan Club, Washington, D. C., on September 17th.

The meeting was called to order by the presiding officer, Levin H. Campbell, Association president.

The following Committee members were present: Harvey C. Knowles, Herbert A. Gidney, Louis Polk, Robert L. Biggers, Henry N. Marsh, Florence G. Ferriter, Burton O. Lewis, and Leo. A. Codd.

A resolution memorializing Col. Henry Parsons Erwin, late treasurer and director of the American Ordnance Association, was read and approved. A committee was appointed to nominate a treasurer and a director to serve for the remainder of Colonel Erwin's term which expires on December 31, 1954.

The following additional Technical Divisions were established: Combat Vehicles, under the chairmanship of R. T. Keller; Guided Missiles, under the chairmanship of C. L. Eksergian; and Component Materials, under the chairmanship of Henry N. Marsh.

A committee was appointed to evaluate essays submitted for the James L. Walsh prize essay contest for 1953.

A board was appointed to consider and report on Reserve Ordnance Technical Manpower, the report to be adopted by the Board of Directors and to become Association policy similar to the Blandy Board Report.

A committee was appointed to nominate members at large of the Association's Council for terms of one year beginning January 1, 1954.

A nominating committee also was appointed for the Association's Board of Directors for terms of four years beginning January 1, 1954.

Following the meeting, a luncheon was held at the club.

Special guests included the Hon. Charles S. Thomas, Assistant Secretary of Defense (Supply and Logistics); the Hon. Frank D. Newbury, Assistant Secretary of Defense (Applications and Engineering); the Hon. Donald A. Quarles, Assistant Secretary of Defense (Research and Development); Col. John Slezak, Assistant Secretary of the Army (Matériel); and Brig. Gen. Anthony J. Drexel Biddle, Assistant to the Chief of Staff, U. S. Army.

Representing the Army were Maj. Gen. John K. Christmas, Maj. Gen. E. L. Cummings, Maj. Gen. L. E. Simon, Brig. Gen. D. L. Van Syckle, Brig. Gen. J. H. Hinrichs, Brig. Gen. Henry R. Westphalinger, and Brig. Gen. J. B. Medaris.

Navy guests included Rear Adm. M. F. Schoeffel, Rear Adm. W. McL. Hague, Rear Adm. Thomas B. Hill, Capt. Edward L. Woodyard, and Capt. J. F. Byrne.

The Air Force was represented by Lieut. Gen. L. C. Craigie, Maj. Gen. W. D. Eckert, Brig. Gen. L. I. Davis, and Brig. Gen. S. O. Ross.

• **AT WASHINGTON.**—The Washington Post attracted a large turnout for its Golf and Dinner Meeting at the Army and Navy Club on October 6th. During the day, in spite of rain squalls and chilly winds, some 180 golfers turned out to compete for the many fine prizes. After the dinner meeting, where Post President Ludlow King presided, Thomas McCloskey and Fred Marshall acted as masters of ceremonies to present golf prizes and draw for door prizes in the ballroom of the club.

The Benjamin F. Fairless Trophy for the low gross score was won by R. H. Rife of Hubeny Brothers Corporation. This trophy was just established by the U. S. Steel Corporation as an annual prize to be competed for by any member of the American Ordnance Association.

The trophy is a large silver bowl and the winner each year will receive a small replica. The presentation of this trophy was made by Grover Plowman, senior vice-president of the U. S. Steel Corporation.

The other outstanding prize in the day's competition was a replica of the L. A. McCaffrey Trophy established this fall by the International Harvester Company in honor of their president for the low net score in the annual A.O.A. golf tournament. James C. Coffman of Coffman & Hagerty won and will be the first to have his name inscribed on this beautiful bowl. The presentation was made by C. P. Crawford, Washington office manager of the International Harvester Company.

Some twenty other golf prizes were awarded for such achievements as longest drive, low and high scores on par three

Stanley C. Hope

Stanley C. Hope, president of Esso Standard Oil Company, New York, is widely known throughout the Ordnance fraternity. He was elected a director of the American Ordnance Association at the September meeting of the Association's Executive Committee to serve the unexpired term of the late Col. Henry P. Erwin.

A native of Springfield, Mass., he became president of the Gilbert & Barker Manufacturing Company in 1932. During World War II he served as chairman of the Army's Remote Control Systems Group. He is president of the Hartford-Springfield Post of the American Ordnance Association.

holes, and other complex scoring feats that caused Roy Devereaux some anxious moments in his computations.

After all the golf honors were distributed, a drawing for door prizes got under way, utilizing the large Benjamin F. Fairless and International Harvester Trophy bowls as ticket containers. Due to the great generosity of a list of companies too long to enumerate, some 200 door prizes were taken home by those with lucky numbers.

The climax was the final drawing by all hands for a large TV set donated by the Crosley Division of Avco, and a modern kitchen sink donated by Hubeny Brothers, Inc., of Roselle, N. J.

These were won by W. Van R. Gilbert of the Aluminum Company of America and Oliver G. Green of the Bureau of Ordnance, respectively. Frank Hughes of Avco presented the TV set and R. H. Rife, on behalf of Hubeny Brothers, presented the shining kitchen equipment. The meeting adjourned with few of the members of the Post or guests leaving empty-handed.

Arrangements were made at the meeting for eighty members of the Post to take a trip on one of the U. S. Navy's aircraft carriers. The trip was arranged for November 3rd and 4th, with a small carrier task force leaving from Norfolk Naval Base, Norfolk, Va.

• **AT ST. LOUIS.**—Through the cooperation of the presidents of three railroads—Don Fraser, H. A. DeButts, and Armstrong Chinn—the St. Louis Post was able to have an 8-car train available for the transportation of more than 400 members and guests from St. Louis to Scott Air Force Base for a general inspection tour on September 19th.

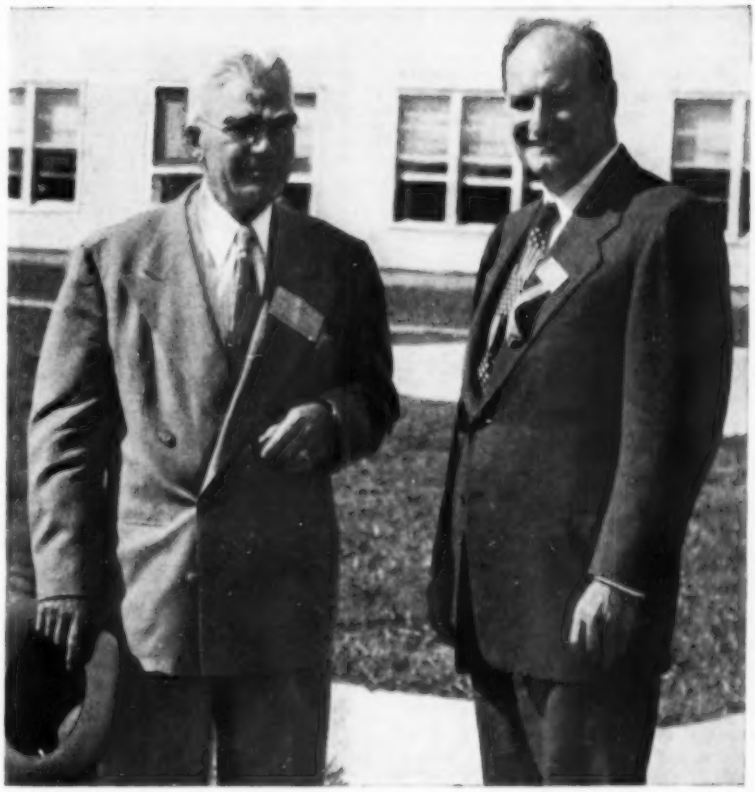
The trip was made possible by invitation of Col. C. I. Ferris, commander of Scott Air Force Base.

Members of the program committee included Dave Smith, J. B. McKee, Stanley Jackes, Ashley Gray, Walter L. Siegerist, Vincent Ring, and Irvin Jerger.

The special train left Union Station at 12 o'clock noon. An enjoyable lunch was served to members in the officers' dining room at Scott Field at 1:30 o'clock. Of special interest was the fact that the complete redecoration and all the furnishings in the Officers' Club were provided by the officers themselves, without any expense whatever to American taxpayers.

The luncheon was followed by a movie about the atomic bomb and a talk by Brig. Gen. George F. Schlatter, deputy chief of staff for operations of the Air Training Command, on the military and civilian aspects of the bomb.

Post members were then taken through the Air Force School where various pieces of equipment used in the instruction of students were displayed.



Walter Siegerist, left, president of the St. Louis Post, chats with V. P. Ring during the Post's inspection tour of Scott Air Force Base on September 19, 1953.

Next came a tour of the field in Scott Air Force buses.

The finale was a special air demonstration, known as a "scramble," by the flyers assigned to the defense of St. Louis.

At 4:30 o'clock, members boarded the train for the return trip to St. Louis.

General Vincent Addresses Meeting of Aberdeen Proving Ground Post

Brig. Gen. T. K. Vincent, former deputy commander at Aberdeen Proving Ground, Md., returned on September 22nd to address the Annual Fall Meeting of the Aberdeen Post of the American Ordnance Association.

General Vincent is now the commanding general at Redstone Arsenal, Huntsville, Ala. He attended the dinner at the special invitation of Brig. Gen. Willis R. Slaughter, deputy commander at Aberdeen.

Speaking before the distinguished assembly of 165 members and guests, General Vincent proved his reputation as a speaker with an entertaining and informative talk on the operations at Redstone.

The speech itself emphasized two major areas: the similarity of operations and problems between Redstone and Aberdeen and the work of former German scientists on guided missiles.

The work of the former German scientists drew high praise from the general. He had nothing but the deepest appreciation and confidence in the men who, a few years ago, had worked on the development of the V-2 bomb for the German government. Now they have come to the United States to lend their talents and brilliant minds to the American defense program.

Led by Dr. Wernher von Braun, the 120 scientists have taken steps toward complete Americanization and have become active in the community life around Huntsville.

Dr. von Braun, in General Vincent's words, is the world's recognized authority on the V-2.

Gerald A. Gustafson is president of

Maj. Gen. James D. McIntyre, U. S. Air Force (Retired), distinguished officer of the Ordnance Department of the Army and of the United States Air Force, was appointed treasurer of the American Ordnance Association at the September meeting of the Executive Committee. He succeeds the late Col. Henry P. Erwin as treasurer.

General McIntyre was born at West Point, N. Y., the son of the late Maj. Gen. Frank McIntyre. He served in positions of great responsibility in Army Ordnance and in the Air Force, and as Comptroller for the Ordnance Department of the Army throughout the period of the Second World War.

Maj. Gen. J. D. McIntyre

the Aberdeen chapter of the Association. A membership drive was held in conjunction with the annual dinner and realized about fifty new members.

Attending the dinner meeting were Maj. Gen. Jonathan L. Holman, commanding general of Aberdeen Proving Ground, and Col. W. E. House, Assistant Chief of Ordnance for Manpower.

• **AT WATERTOWN.**—The Secretary of the Navy and Rear Adm. Charles B. Momsen recently extended an invitation to the Yankee Post to make a cruise on a fleet carrier.

A 2-day indoctrination cruise aboard the U.S.S. TARAWA was arranged for November 3rd and 4th in the vicinity of Norfolk, Va. The cruise included day and night task group operations.

• **AT SAN FRANCISCO.**—Dean Witter, a national vice-president of the American Ordnance Association and civilian chief of the San Francisco Ordnance District, was host at luncheon at the Pacific Union Club on July 29th.

The luncheon meeting was held in honor of Levin H. Campbell, president of the Association, in connection with his visit to the West Coast.

The board of directors of the San Francisco Post in attendance at the luncheon heard General Campbell speak on the special report made to the Secretary of Defense on Reserve Ordnance Production Capacity.

General Campbell emphasized the necessity for maintaining the present defense plants in a stand-by condition, ready to go into instant production should an emergency arise. He further stressed the importance of keeping these plants equipped with the latest technological developments through a continuing replacement of machine tools which may become obsolete during the stand-by period.

He contrasted this requirement with the action taken after the previous wars in disposing of defense plants and other production facilities.

General Campbell asked that directors and members of the San Francisco Post talk "Ordnance" in their daily contacts with defense-minded citizens. He asserted that the American Ordnance Association can play a major rôle in disseminating vital information on the importance of effecting and assuring the continued sup-

Among the guests at the Aberdeen Post Meeting were, left to right: Col. W. E. House, Assistant Chief of Ordnance for Manpower; Brig. Gen. W. R. Slaughter, commanding the Ordnance Training Command; D. C. Jackson, Post vice-president; Maj. Gen. J. L. Holman, commander of Aberdeen; G. A. Gustafson, Post president; and Brig. Gen. T. K. Vincent, commanding Redstone Arsenal.

The above A.O.A. members conducted a press conference on reserve ordnance production capacity at San Francisco in connection with the Post meeting there. Left to right are: Col. C. D. Hudson, Sixth Army Ordnance Officer; B. C. Heacock, president, San Francisco Post; Levin H. Campbell, Association president; Dean Witter, national vice-president; Col. John M. Stark, deputy chief of the San Francisco Ordnance District. General Campbell was the principal speaker at the Post luncheon.

port of this new national-defense idea.

B. C. Heacock is president of the San Francisco Post which now numbers more than 500 members.

Other members of the board of directors in attendance at the luncheon were Lawrence S. Fletcher, vice-president of the Post, Adm. George D. Murray (Ret.), Colonel Witter, Edgar B. Jessup, and Elmer R. Peterson.

Col. John M. Stark, deputy chief of the San Francisco Ordnance District, and Col. C. D. Hudson, Sixth Army Ordnance Officer, both active members in Association affairs, represented the Ordnance Corps, along with Capt. Marion W. Harris, secretary of the Post.

• **COL. ANGELO RALPH DELCAMPO,** project officer and coordinator of the Ordnance aspects of America's atomic artillery program, has been appointed Director of the Ballistic Research Laboratories at Aberdeen Proving Ground, Md.

He replaces Col. Alden P. Taber who has been assigned to the Industrial College of the Armed Forces, Washington, D. C.

Colonel Delcampo is well known for his part in the Army's successful atomic artillery project, for which much of the testing was done at Aberdeen.

A West Point graduate with twenty-two years of active service, the colonel has long been a student of Latin-American affairs, an interest that was largely responsible for his assignment to Ecuador in 1943 as chief of the military mission.

• **ALBERT E. FORSTER** was elected president of Hercules Powder Company on April 29th, succeeding Charles A. Higgins. Mr. Forster had been a vice-president of the company since 1951.

J. B. Johnson, general manager of the explosives department of Hercules and a member of the company's board of directors since 1945, was elected a vice-president on July 29th. On the same date John M. Martin was appointed general manager of explosives, succeeding Mr. Johnson.

William R. Ellis resigned as a member of the Hercules executive committee but remained as a vice-president and director.

• **AT ROCHESTER.**—The full potential of peacetime atomic energy can be realized only if it is developed competitively by American industry.

This view was expressed by Walker L. Cisler, president of the Detroit Edison Company, in a speech delivered at the annual dinner of the Empire Post which was held at the Oak Hill Country Club here on September 24th.

Approximately 400 members and guests attended the dinner.

Mr. Cisler stressed the need for relaxation of the laws which keep atomic energy a Government monopoly. He said that it will be necessary to mobilize the complete industrial resources and manpower of the Nation if full development of nuclear energy is to be realized.

"It is a challenge to industry," he declared, "to carry it forward."

Having recently returned from an inspection of power facilities in Western Europe and the Near East, Mr. Cisler said the ten nations he visited look to the United States to carry out the civilian and industrial development of atomic energy. They recognize, he explained, that only American industry has the resources and know-how to make it possible.

"I am sure atomic energy will have its greatest usefulness in industry if we think of it as another source of energy," he said.

Mr. Cisler, who is chairman of the Dow-Chemical-Detroit Edison Nuclear Power Project, cited studies made on the replacement of conventional steam power by atomic reactors to show the use of nuclear fission as a fuel.

Rep. Kenneth B. Keating, who welcomed the guests, spoke of the "great productive genius" of America and reasserted his belief in the ability of industry to produce the necessary materials to meet any emergency.

Dr. Cornelis W. de Kiewiet, president of the University of Rochester, described the rôle played by American universities in supplying the technical manpower required to fulfill the needs of the future.

A highlight of the meeting was the showing of the film "The Atom," pro-

Among the guests of honor at the annual dinner of the Empire Post were, left to right: Capt. John D. Shea, U.S.N., University of Rochester; Walker L. Cisler, president, Detroit Edison Company; Robert E. Ginna, executive vice-president, Rochester Gas & Electric Company; and Maj. Gen. Richard C. Lindsay, U.S.A.F., commanding general of the Sampson Air Force Base.

duced by General Electric Company. It illustrated the peacetime development of atomic power.

Bishop James E. Kearney of the Catholic Diocese of Rochester gave the invocation. The Rev. Gerald Watkins, pastor of the Lake Avenue Baptist Church, pronounced the benediction.

Carl S. Hallauer is president of the Empire Post. Other officers are Ray C. Malvin, first vice-president; Francis R. Gorman, second vice-president; Col. Edward G. Miller, secretary; Raymond M. Biehler, treasurer; and August J. Zimmerman, Post representative on the national Council.

Sponsors of the dinner included Alexander M. Beebee, Mr. Biehler, M. H. Eisenhart, Mark Ellingson, B. Emmet Finucane, James E. Gleason, E. T. Gruendike, T. J. Hargrave, Myron J. Hayes, William A. Lang, Paul Miller, Thomas H. Remington, H. A. Schumaker, Lewis B. Swift, Joseph F. Taylor, A. Richard Todd, and C. L. Van Derbogart. Mr. Hallauer presided at the dinner.

Necrology

• **COL. FREDERICK E. WRIGHT,** distinguished Ordnance officer in World War I and world-renowned scientist who was a charter member of the American Ordnance Association, died at his summer home in the Thousand Islands on August 11, 1953.

He was a charter member of the Washington Post of the Association and resided in the Nation's capital where he was formerly home secretary of the National Academy of Sciences and petrologist of the Geophysical Laboratory of the Carnegie Institution.

Colonel Wright was widely recognized for his contributions to the development and manufacture of optical glass in the United States during the First World War. In the execution of national policies in this field he served as a colonel of the Ordnance Department of the Army and was highly commended. In the Second World War he served as chief physicist in the Air Service Force and was awarded the Army's Exceptional Service Medal in 1945.

Colonel Wright was born in Marquette, Mich., and received his early education in that State. He was awarded the degree of doctor of philosophy from the University of Heidelberg, Germany, in 1900. He began his teaching career at the Michigan College of Mines in 1901 and later served as State geologist. Beginning as petrologist at the Geophysical Laboratory of the Carnegie Institution he continued with that organization until his retirement in 1944.

His contribution to the optical-glass industry in the United States during the First World War was of major importance.

Colonel Wright was a fellow member of the American Academy of Arts and Sciences, the Physical Society of London, and the American Association for the Advancement of Science. He served as president of the Optical Society of America and also of the Mineralogical Society of America.

He was vice-president of the National Academy of Sciences from 1927 to 1931 before becoming home secretary. Most active and loyal in his allegiance to Army Ordnance, Colonel Wright helped found the Washington Post of the Ordnance Association and throughout his life was a most interested and regular participant in its activities. He is mourned by the Ordnance fraternity, not only in the Nation's capital but throughout the land.

• **BRADFORD C. COLCORD,** former president of the Woodward Iron Company, died in Boston on August 16th.

During World War I, he served as an ensign in the Navy. A graduate of the University of Michigan, he was superintendent of blast furnaces at the Crucible Steel Company, Midland, Pa., from 1926 to 1930 and was associated with the St. Louis Gas and Coke Company, Granite City, Ill., from 1930 to 1933.

He was first employed by the Woodward Iron Company in 1935 and, after a number of years as an executive of the National Tube Company, he returned to Birmingham to serve as president and director of Woodward in 1948.

• **DONALD H. MONTGOMERY,** vice-president and director of the New Britain Machine Company, New Britain, Conn., died on August 13th at his home in Farmington, Conn., after a short illness.

He was well known in the machine-tool field and held many patents on machinery mechanisms.

In 1927 he founded the Gridley Machine Company which eventually evolved into the New Britain Machine Company in 1936.

• **LAWRENCE RADFORD,** technical representative of the Farrand Optical Engineering Company of New York, died in Washington, D. C., on August 19th after a long illness.

A retired Navy Department engineer, Mr. Radford retired from the Bureau of Ordnance in 1952 after thirty-five years' service. Since then he had been with the New York company.

Mr. Radford received two Meritorious Civilian Service awards while with the Bureau of Ordnance. One of the awards was for developing production facilities for critically needed optical glass.

• **JOHN HOWE HALL,** metallurgical engineer, who was instrumental in the development of steel castings for military and naval armor in World War II, died in August at his home in Tarrytown, N. Y., at the age of 72.

Mr. Hall pioneered in the heat treatment of steel used in the manufacture of cast armor. He started his career with the Taylor-Wharton Iron & Steel Company of High Bridge, N. J., after his graduation from Harvard in 1903.

ENGINEERING MATERIALS PROGRESS

George S. Brady

HIGH prices paid by the military do not necessarily indicate waste or extravagance. The vast amount of experience we have gained in the alloying and working of titanium metal would have been difficult to get by laboratory research, and we might not have had this valuable construction metal if the armed forces had not been willing to take quantities at the high prices necessitated by the cost of production in the initial stages.

• New materials with unique properties are constantly being developed for industrial and military uses, and new processes and applications are being found for familiar materials. A knowledge of these developments is of such importance to the members of the Science-Industry-Ordnance Team that this department is being inaugurated as a regular feature of ORDNANCE.

• Colonel Brady, who will compile and edit the data, is a recognized expert on industrial materials and a consultant on this subject. He is the author of "Materials Handbook"—universally accepted as an authentic sourcebook of materials information.—THE EDITORS.

New Production Goal

The new production goal set by ODM is for 25,000 tons annually, and practically all the production is going into military items as it is still too expensive for any ordinary civilian products. But if one Navy project now under way achieves its goal, the cost of the metal may be cut drastically.

Titanium weighs only 60 per cent as much as steel, but the strength of alloyed titanium is such that designs can be made more compact with great savings in weight for high-strength parts. Typical is the base of the Army's 81-mm. mortar, with only half the weight of the former steel base and much stronger.

An important fact is that the metal does not require scarce strategic elements for alloying; small additions of oxygen, nitrogen, or iron will raise the tensile strength and the yield point 400 per cent. Another valuable point is that the very property that makes titanium difficult to roll—its hexagonal crystal structure—makes it extremely difficult to pierce with a rifle bullet. It thus has big possibilities for tanks, armor, and ship superstructures.

According to the United States Geological Survey, titanium is 200 times more abundant than copper. There are large resources of the ore in this country and in Canada. What we need now is a low-cost method for reducing the ore to metal.

Magnesium is another metal that is finding wider fields of use. It is lighter than aluminum, but is stiffer and more rigid. The Patent Scaffolding Company is offering magnesium ladders in sizes from four to forty feet. The 20-foot ladder weighs only 25 pounds, and the 30-foot extension ladder weighs only 50 pounds. One man can handle the long ladders, and because of their stiffness they have little curve or sway.

The latest Sikorsky S-55 helicopter is made almost completely of magnesium sheet and about a hundred magnesium castings. The 13,000-horsepower Navy R7V-1 transport and cargo plane has flooring of extruded magnesium sections. The floor will carry a load of 1,000 pounds per linear foot or 300 pounds per square foot.

Of the gross weight of 358,000 pounds in the B-36 bomber built by Consolidated Vultee there are about 12,000 pounds of magnesium, of which 9,000 pounds are in the airframe.

American Pulley Company has a new lightweight 2-wheeled hand truck with the frame and telescoping handles made of magnesium. Magline, Inc., also has a hand truck made entirely of magnesium that weighs only 19 pounds and will take a load of 450 pounds.

Magnesium Ramps

Dock boards, or ramps, for loading freight cars are being made of magnesium so that they can be handled by one man. A magnesium ramp offered by the Penco Engineering Company is 42 inches wide and 36 inches long and weighs only 47 pounds. Magline also has lightweight tongs made entirely of magnesium.

Large-size pipe wrenches up to three feet in length are being marketed by the International Forge Company in forged 14S-T6 aluminum alloy. The jaws are either of steel or beryllium bronze. The wrenches weigh only a third as much as steel wrenches of equal capacity and they are easier to keep clean.

To replace scarce and expensive alloys Alcoa is offering aluminum storage tanks made up in standard sizes in capacities from 5,800 to 16,400 gallons in both vertical and horizontal types. The tanks are made of ¼-inch welded 3S aluminum alloy.

With more availability of aluminum in the offing, Alcoa is also going after more of the pipe business from the small sizes used for railings and scaffolds to the big-inch pipes for oil fields. Aluminum heat-exchanger tubes are being offered at only 50 per cent of the cost of Admiralty metal tubes, and 20 per cent of the cost of stainless-steel tubes.

At the same time Kaiser is featuring weatherproof insulated aluminum wire. Cost of the wire is about 30 per cent less than insulated copper wire of the same current-carrying capacity.

An aluminum truck trailer, 32 feet long, made by American Body & Trailer, Inc., weighs 7,939 pounds and will carry a load of 25 tons. The extruded parts are of 62S aluminum alloy, and the side sheets are of 0.072-inch 24S aluminum alloy.

Aluminum Conveyors

For production conveyor systems that require moving about, Speedways Conveyors, Inc., is offering lightweight gravity conveyor sections with aluminum channel side frames. The roller wheels are steel with ball bearings, but the total weight is 33 per cent less than steel conveyors. Load capacity is 85 pounds per foot.

Springfield Tent & Awning Company is producing lightweight tarpaulins of any size made from nylon fabric coated with vinyl plastic. The weights are 5 and 9 ounces per yard for the coated material. Besides good strength and flexibility, the fabric is waterproof, resistant to chemicals and to rot.

Thomson Industries has solved mechanical difficulties of nylon bearings by having a spiral compensation gap in the nylon lining. The gap also serves to distribute lubrication. The bearings, with an outer sleeve of drawn steel and a thin nylon liner, are in sizes from ¼ to 1¼ inches.

The transmission speedometer pinion and shaft, driving gear, and governor pinion of the 1953 Packard are of nylon instead of brass. The reduction in weight reduces inertia, cost is lower, and the parts are more durable.

A 26-foot Diesel-driven yawl with 34-inch draft and 8-foot beam built by the Cape Cod Shipbuilding Company is made of glass-fiber mat reenforced with a polyester plastic. It has 1,600 pounds

less displacement than a wooden boat of equal size and can travel 30 per cent faster with a 30 per cent greater load. It is more durable than a wooden boat, needs no painting, and is easier to keep clean.

Mission Manufacturing Company is putting out a new centrifugal pump with plastic parts for resistance to chemicals and corrosive liquids. The plastics employed are phenol-formaldehyde and furfural-alcohol with asbestos and graphite fillers. They will withstand temperatures to 265 degrees Fahrenheit. The pump has a 2-inch discharge pipe and at 1,750 r.p.m. delivers 300 gallons a minute.

Plastic Valves

Globe valves of large size are now being made by the American Agile Corporation completely of polyethylene plastic. They are intended to replace high-alloy valves for handling acids and corrosive chemicals.

Vantom Pump Company also has a new line of globe valves of polyethylene which will withstand working temperatures to 150 degrees Fahrenheit and pressures to 50 pounds per square inch. Sizes are ½ to 2 inches.

A 2-inch polyethylene globe valve weighs less than 6 pounds. After a long series of service tests the Navy Bureau of Ships found that nylon inserts in globe valves subject to the high-velocity flow of sea water gave much longer wear life than former Monel-metal valve seats.

U. S. Textile Machinery Company is now producing its thread guides of Alsimag ceramic instead of metal. The ceramic gives a uniformly smooth working surface and a very long wear life compared with that of metal guides.

Lapp Insulator Company now has a full line of porcelain pipe, fittings, and valves armored with a heavy coating of glass-fiber-reenforced black epoxy plastic. The plastic covering permits an increase in operating pressures and also decreases impact and thermal shock damage.

Arc-resistant tube sockets of high dielectric strength are now being injection-molded of glass-bonded mica flake by the Mycalex Tube Socket Corporation. The material will withstand continuous temperatures to 700 degrees Fahrenheit.

Dow Corning Corporation has a new magnet wire enamel, No. 1360, which will give as long a service life at 390 degrees Fahrenheit as the best organic enamels give at 220 degrees Fahrenheit. The enamel has a silicone resin base, is resistant to solvents, and its flexibility is comparble with that of high-grade organic enamels.

General Electric has a new magnet wire that has insulation of very high dielectric strength for working temperatures to 221

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SAVE TIME in packaging . . . EXPEDITE repairs by having available spare parts needing frequent replacement.

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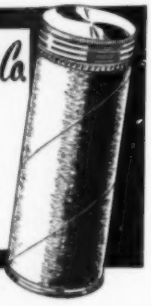

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This installation of 36 H-P-M All-Hydraulic Cartridge Case Presses at the Riverbank Ordnance Plant, Riverbank, California will give you an idea of the important part pressure processing and H-P-M play in this phase of America's defense program.

Heavy-duty design, semi-automatic, accurate control and exceptionally fast, smooth, shockless operation are good reasons why so many H-P-M cartridge case drawing, tapering and heading presses are now working round-the-clock production all over the country.

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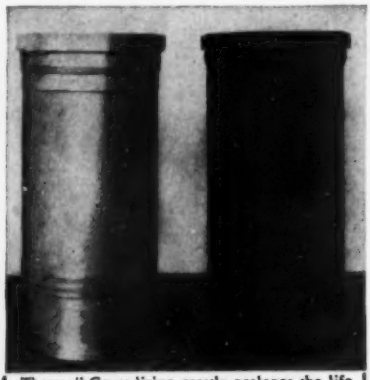
Technical Service Data Sheet
Subject: PROTECTING FRICTION SURFACES WITH THERMOIL GRANODINE®

INTRODUCTION

Fabricators and product designers, particularly in the automotive field, are aware that even highly polished surfaces under friction weld, gall and score. One of the most inexpensive and practical methods of preventing this is to coat the metal to prevent metal-to-metal contact. With cast iron or steel, the "Thermoil-Granodine" manganese-iron phosphate coating provides a wear-resistant layer of unusual effectiveness.



Thermoil-Granodizing greatly prolongs the life of parts subject to friction. It protects the surface of products like the diesel engine liners shown above and the many moving parts of automobiles and other machines. "Thermoil-Granodine" with its remarkable lubricating properties is particularly valuable in these and similar applications because of its ability to retain oil and maintain lubrication under high pressures and high velocities. This ACP wear-proofing chemical not only permits rapid break-in without scoring, scuffing and welding but also reduces subsequent wear on friction parts.

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Thermoil-Granodizing removes "fuzz" from ferrous metal friction surfaces and produces a coating of non-metallic, water-insoluble manganese-iron phosphate crystals which soak up and hold oil as bare untreated metal cannot do. The oiled crystalline "Thermoil-Granodine" coating on piston rings, pistons, cylinders, cylinder liners, cranks, cam-shafts, gears, tappets, valves, spiders and other rubbing parts, allows safe break-in operation, eliminates metal-to-metal contact, maintains lubrication and reduces the danger of scuffing, scoring, welding, galling and tearing of the metal. The work to be protectively treated is merely Thermoil-Granodized and oiled, usually with a soluble oil.

"THERMOIL-GRANODINE" MEETS THESE SPECIFICATIONS

SPECIFICATION NUMBER	SPECIFICATION TITLE
MIL-C-16232 Type I	Coatings — phosphate; oiled, slushed, or waxed (for ferrous metal surfaces) and phosphate treating compounds.
AN-F-20 (See also U.S.A. 3-213)	Finishes, for electronic equipment.
U.S.A. 57-0-2C Type II, Class A	Finishes, protective, for iron and steel parts.
U.S.A. 51-70-1 Finish 22.02, Class A	Painting and finishing of fire control instruments; general specification for
M-364	Navy aeronautical process specification for compound phosphate rust-proofing process.

(CHEMICALS ACP PROCESSES)

WRITE FOR FURTHER INFORMATION ON "THERMOIL-GRANODINE" AND ON YOUR OWN METAL PROTECTION PROBLEMS.

(CHEMICALS ACP PROCESSES)

degrees Fahrenheit. The insulation is a combination of two sheets of asbestos paper with a polyester film between. It is spirally wound on the round or square wire with an overlap of 25 per cent and bonded with a resistant adhesive. It will not crack or unravel.

Pure silicon metal is now being made commercially by Du Pont for use in rectifiers, transistors, and electronic devices. It is superior to the scarce germanium in transistors as it will withstand temperatures to 400 degrees Fahrenheit and has higher power capacity.

In rectifiers it permits the making of smaller units than selenium. The purified metal is costly, but since the element is plentiful in nature the supply can be more continuous and reliable than that of the scarcer germanium and selenium. Amounts needed per unit are so small that the unit cost is low.

Nubone Company is offering traffic signs in glass-fiber-reënforced polyester resin in white and yellow, with legends painted with durable silicone resin enamels. The tensile strength is 20,000 p.s.i., and flexural strength is 30,000 p.s.i. They are more durable than metal signs.

Rhodium Plating

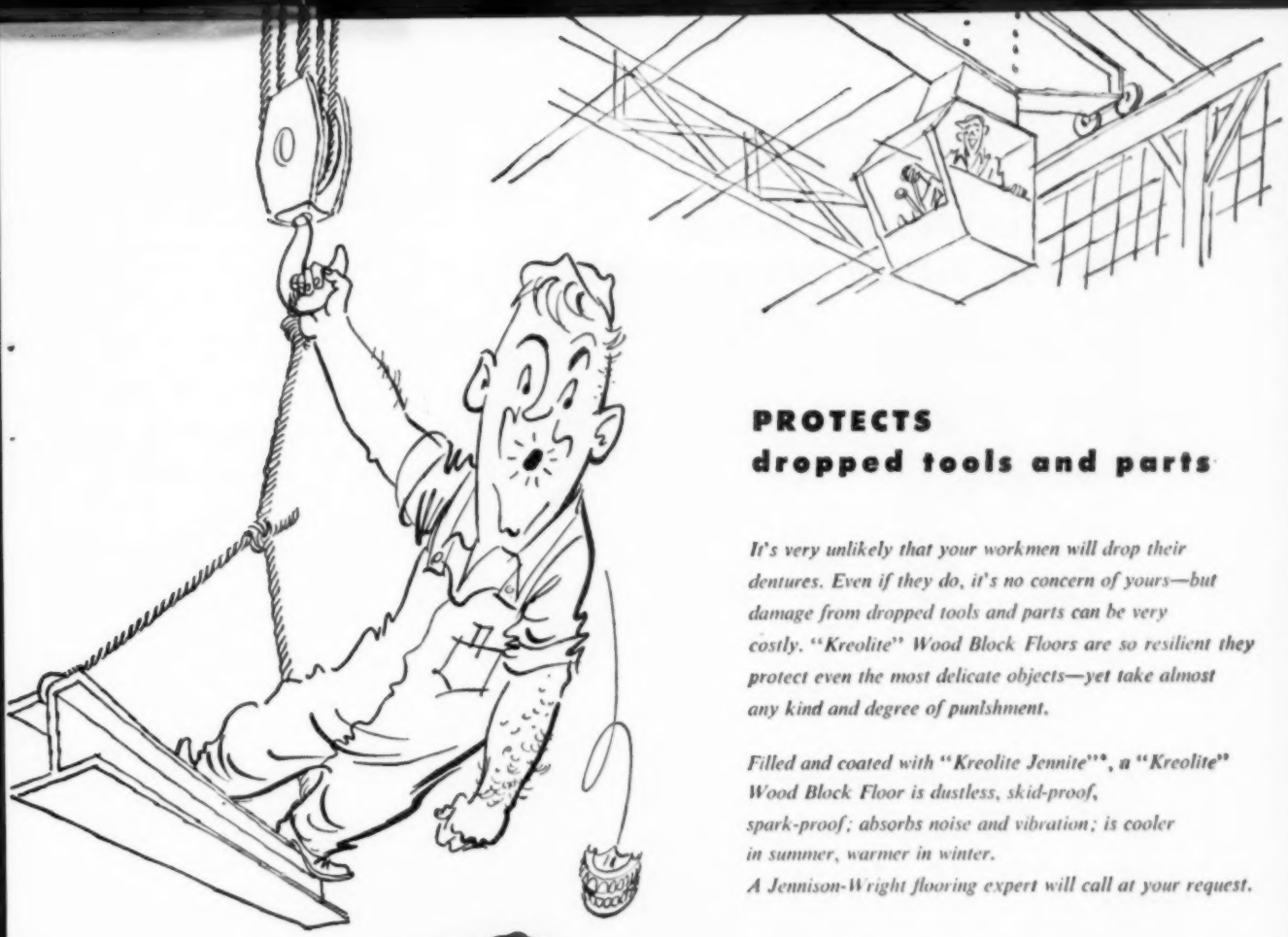
Technic, Inc., is offering plating salts and a method for rhodium plating to give coatings up to 0.001-inch thick. The plate is recommended for parts subject to extremely corrosive conditions and for tarnishproof mirrors and reflectors.

Bendix Aviation Corporation has been successful in obtaining heavy electroplates of rhodium that are adherent and do not crack. The plate is a brilliant silvery white, is hard, and is highly corrosion-resistant. For plating on brass or steel a flash coat of silver is first applied. Coatings of 0.0001-inch will give a long wear life, but for severe service conditions, such as for electrical contacts, coatings of 0.0005-inch may be obtained.

Both Du Pont and General Dyestuff Corporation are now in production on chemical pigments that do not require highly strategic elements in their manufacture, and they give permanence, chemical resistance, high tinting strength, and resistance to high-temperature baking, a combination often difficult to obtain especially in blue and green pigments.

The materials are metallic salts of tetrabenzo porphyrazine which is made from ammonium phthalic anhydride in the presence of iron, copper, or other metal salts. The blue is the copper salt in which the copper is held in a complex with four nitrogen atoms. The green is made by chlorination of the blue.

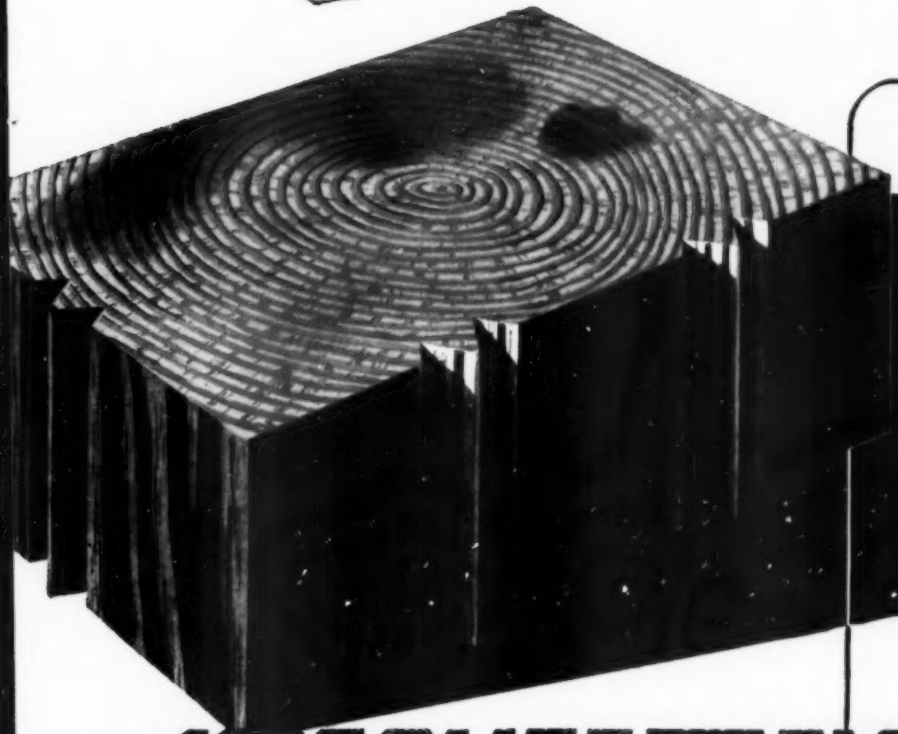
Bissell Carpet Sweeper Company is using polyvinyl chloride bristles in the brushes of its sweepers to replace Chinese



PROTECTS
dropped tools and parts

It's very unlikely that your workmen will drop their dentures. Even if they do, it's no concern of yours—but damage from dropped tools and parts can be very costly. "Kreolite" Wood Block Floors are so resilient they protect even the most delicate objects—yet take almost any kind and degree of punishment.

Filled and coated with "Kreolite Jennite", a "Kreolite" Wood Block Floor is dustless, skid-proof, spark-proof; absorbs noise and vibration; is cooler in summer, warmer in winter.*
A Jennison-Wright flooring expert will call at your request.



SPECIFY KREOLITE ... *Hundreds of millions of square feet used by leading industries since 1911*

1 Comfortable to Work Over
2 Durable-Stand Up Under Abuse
3 Protect Dropped Tools and Parts
4 Quick to Install—Easy to Replace
5 A Firm Foundation for Machines
6 Absorb Noise-Cut Down Vibration
7 Insulate Against Heat and Cold
8 Spark-Proof, Skid-Proof, Safe*
9 Provide for Conduits and Cables
10 Dustless-Easy to Clean
11 Good for Trucking Aisles
12 Lowest Maintenance Cost

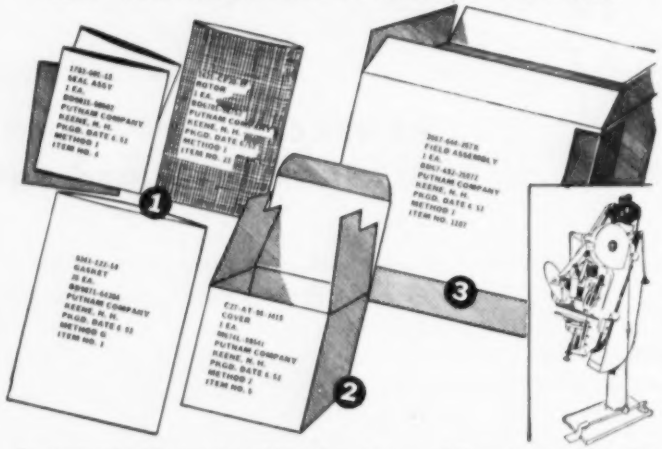
**A "Kreolite" Wood Block Floor is cleaner and better when given a coating of "Kreolite Jennite", our proven exclusive final filler and finish that does not become tacky.*

KREOLITE WOOD BLOCK FLOORS

ALSO "KREOLITE" RAILROAD CROSS AND SWITCH TIES • INDUSTRIAL TRACK TIES • COAL TAR PRODUCTS • BRIDGE & DOCK LUMBER .... THE JENNISON-WRIGHT CORPORATION • TOLEDO 1, OHIO • 30 NATION-WIDE OFFICES

MARKEM SOLVED THIS MARKING PROBLEM

IDENTIFICATION MARKING
FOR CONTRACT AND OVERSEAS PACKING



In contract and export packing of parts, assemblies, etc., certain JAN specifications call for three packaging stages: (1) enclosure in scrimback or polyethylene lined *heat sealing* envelope, (2) intermediate packing in a folding box, (3) final packing in corrugated carton. Each of these three types of containers must be marked for instant and *permanent* identification. Many manufacturers, dissatisfied with conventional marking with crayon, stencil, labeling or other form of hand stamping, have not only found great savings in time and money, but also obtained more legible, longer lasting identification using a Markem Method. *One* Markem machine (with appropriate Markem type and Markem ink) prints desired information on *all three* containers. The vapor barrier of the envelope is not broken. Desired information is changed rapidly. By printing quantities of containers as and when needed, inventory problems are minimized. In this way, the Markem Method insures *positive identification* when the items reach their destination.

MARKEM® MARKS THEM ALL

CAN MARKEM HELP YOU? Identification printing for contract and overseas packaging is but an example of how Markem solves industry's marking problems. Markem has been providing industry with production techniques and equipment to identify, decorate or designate its products, parts and packages since 1911. Markem also provides technically trained men who are available in your area to assure *continued* satisfaction with Markem methods and equipment.

When *you* have a marking problem, tell us about it and send a sample of the item to be marked. Perhaps a complete Markem Method has already been developed to solve your problem. If not, Markem will work out a practical solution.

Markem Machine Company, Keene 9, N. H., U. S. A.

MARKEM ...TO MAKE YOUR MARK

hog bristles. Intensive tests have shown the plastic bristles to be as good as the hog bristles and to be more durable.

Teflon-coated glass-fabric transmission belting is being made by the Voss Belting & Specialty Company. The belting is nonsticking, has good wear resistance, and has high resistance to oils and chemicals.

A new conveyor belt of the Main Belt Company is made of cotton duck coated with a polyvinyl plastic. It has a white color that is easily cleaned, and it is resistant to spotting. It will withstand temperatures to 106 degrees Fahrenheit.

Glass Fabric

An extra-fine sheer glass-fiber fabric of the Soule Mill has been developed for such uses as varnished electrical insulation and resin-impregnated fabric to replace mica for some insulation. The woven fabric is only 0.001-inch in thickness, weighing 0.81-ounce per square yard. The fiber used is a high-strength glass composition of Owens Fiberglas and is of such fineness that one pound of fiber produces 20 yards of fabric 36 inches wide.

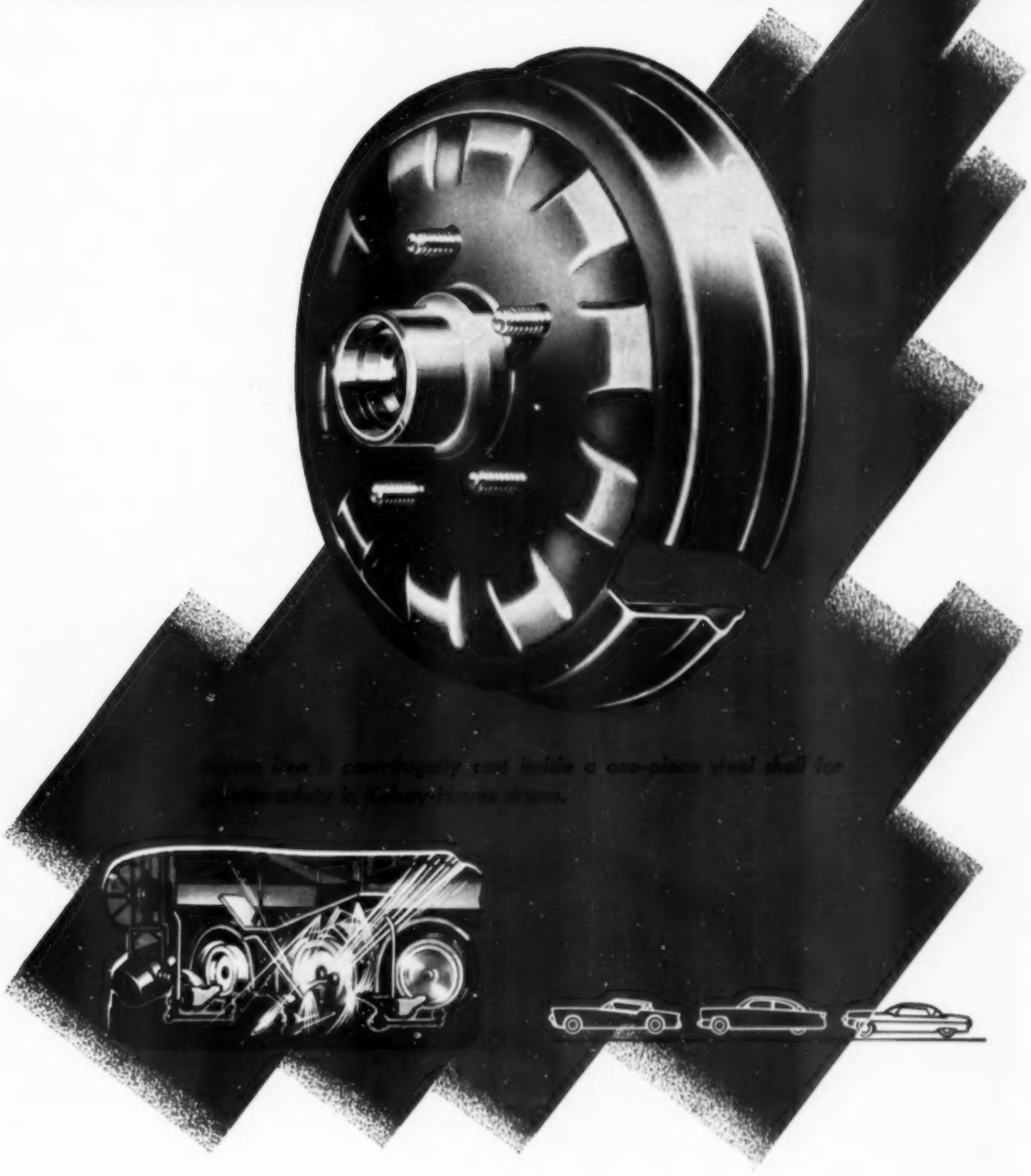
Linde Air Products Company has a new silicone electrical insulation varnish suitable for continuous operation at Class H temperatures or for limited operation up to 480 degrees Fahrenheit. It is designated as R-61 and is for impregnating glass cloth or tape where great flexibility is required. Another silicone with similar characteristics, designated R-62, is for coating coils and armatures.

For hydraulic and pneumatic shaft seals and packings where leather has been the most effective material but has had the disadvantage of oil deterioration, Chicago Rawhide Manufacturing Company has developed Conpor, a chrome retan leather impregnated with liquid Thiokol synthetic rubber. It is stable under exposure to oil, and seals are resistant to leakage at much higher temperatures and pressures than other treated leathers but retain the necessary porosity for lubrication through the seal.

Where a cushioning effect is needed in a sealing and gasket material, Connecticut Hard Rubber Company is offering Fluolastic. The core is silicone rubber, and the outer coating is either Teflon or Kel-F plastic, depending on the corrosive and heat conditions to be encountered. Thicknesses are 3/32 to 1 inch, including the coating of 0.0025- to 0.030-inch.

For making gaskets that must be electrically conductive, Vulcanized Rubber Plastics Company has a sheet material composed of aluminum wire screen with the interstices filled with Neoprene rubber. The material is made by impregnating the screen with the Neoprene and then buffing both sides to a uniform gage.

KELSEY-HAYES



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KELSEY-HAYES WHEEL COMPANY

DETROIT 32, MICHIGAN

PLANTS IN DETROIT AND JACKSON, MICHIGAN; McKEESPORT, PA.;
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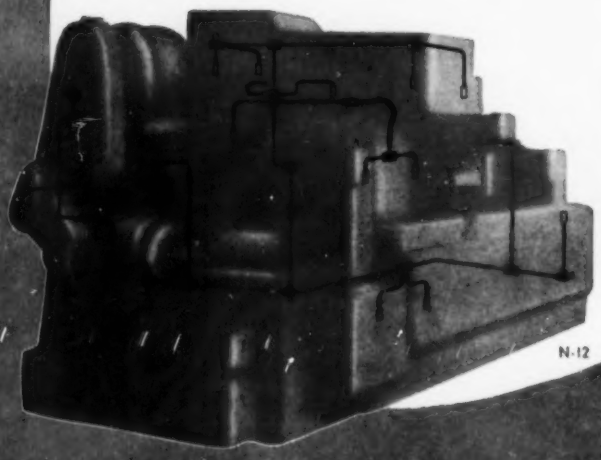
where the BEST is Demanded!

America's leading machine builders *standardize* on Bijur Automatic Lubricating Systems to provide the *best in bearing protection.*

Bijur guards against bearing failure . . . lubricates with the *right amount* of oil at the *right time.*

Specify Bijur on machines now in production or in the planning stage. Assure increased production . . . higher speeds . . . smoother operation and longer machine life.

For recommendations, call in the Bijur engineer.



N-12

BIJUR LUBRICATING CORPORATION
Rochelle Park, New Jersey

NEW DEVELOPMENTS

SECOND ATOMIC SUB

The keel of the SEA WOLF (SSN 575), the second nuclear-powered submarine, was laid recently. The submarine will be built by the Electric Boat Division of the General Dynamics Corporation at their Groton, Conn., yard. The nuclear-powered propulsion machinery for the SEA WOLF is being built by the General Electric Company. A land-based prototype of this machinery has been under construction at West Milton, N. Y., since 1952.

MAINTENANCE JEEP

A maintenance jeep that can put damaged radar gun sights on USAF jet fighters back in working order six times faster than old methods has come out of the maintenance shops of the Air Matériel Command.

The jeep—fully outfitted with a compact package of test equipment and spare components—furnishes the "missing link" between flight line and armament shop in the care of the delicate instruments. Born in the Korean war, where it bought precious time for USAF airmen by getting fighters back into the air faster, the tiny wheeled testing unit is expected to save valuable equipment and countless man-hours in peacetime operations.

Maintenance jeep checks radar gun sights.

NEW MEMORY FOR ENIAC

The Computing Laboratory of the Ballistic Research Laboratories at Aberdeen Proving Ground, Md., announced recently that ENIAC, the world's first all-electronic computer, had received a new "memory" which will greatly increase its ability to solve quickly and economically problems posed by America's new weapons.

The memory consists principally of 4,400 tiny magnets whose polarity may be changed electrically. Like a platoon of soldiers being drilled by an electronic drill sergeant, all the magnets or any number

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If your requirements involve the transmission of power in farm tractors, and if you are thinking in terms of performance, dependability and long service, it is more than likely you'll choose Clark Transmissions. They have been favored by automotive manufacturers for more than a quarter century . . . ample evidence, we believe, that "it's good business to do business with CLARK."
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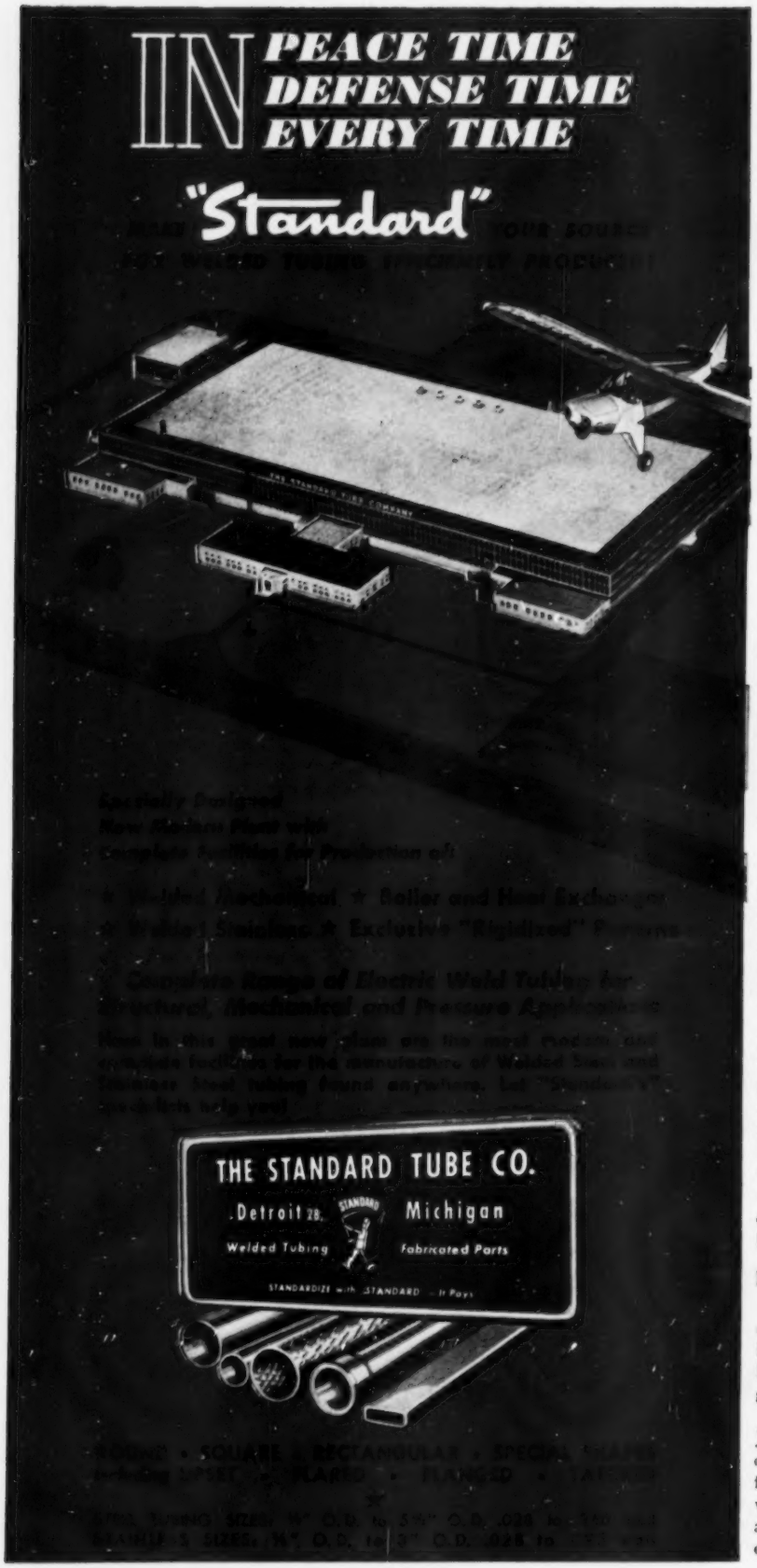


New Developments

of them mark time or turn in place when ordered to do so by the computer or the machine operator. The direction in which the magnetic "soldiers" face later tells ENIAC what to do or enables it to remember answers to problems previously solved.

With the new memory, which increases ENIAC's power of recollection fivefold, the machine will be able to decide for itself what to do when preliminary conclusions are reached on the way to the final solution of a problem.

NEW HONING TOOL

With the successful testing of the new 280-mm. gun on the firing range, Micromatic Hone Corporation, Detroit, Mich., has released details on its 69-foot-long tool which is used to microhone the bore of the gun barrel. The tool has a gage in its nose, making it possible to check the

Honing tool for 280-mm. gun.

diameter of the bore at any point throughout its full length without removing the tool from the bore or the barrel from the machine. This new tool reduces by eighty per cent the time the barrel is at the microhoning machine.

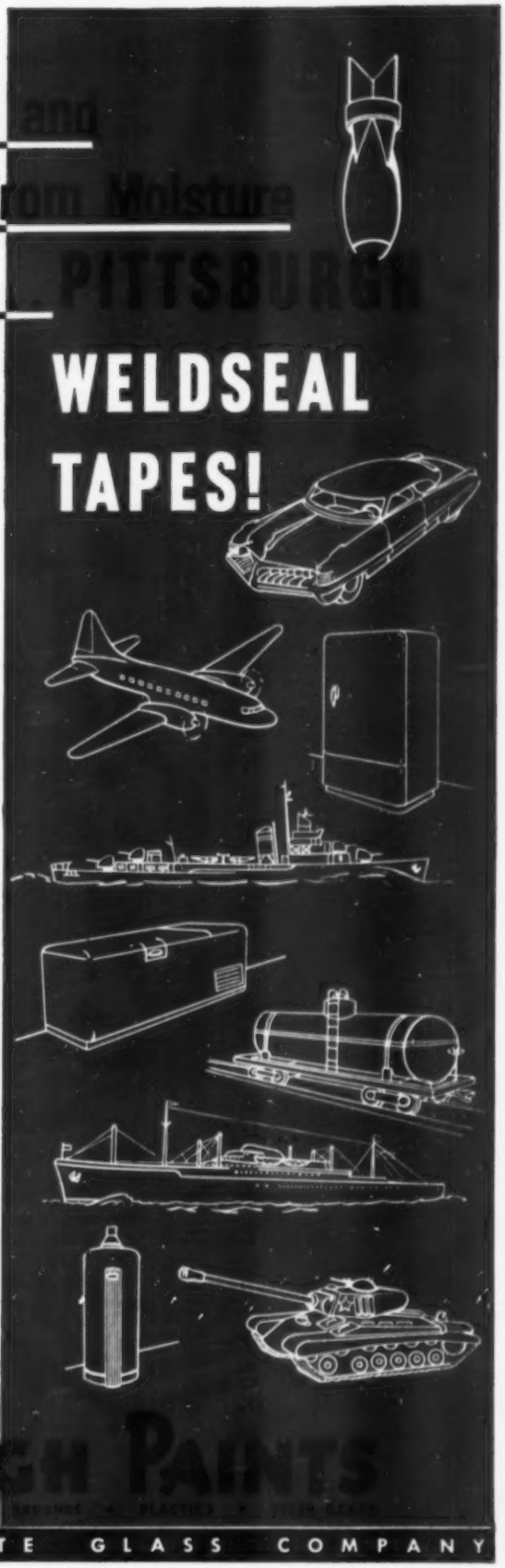
After the barrel has been microhoned to remove all rings, steps, and geometric inaccuracies resulting from previous operations, the diameter is checked in thirty seconds by means of dials at a conveniently located control station. The 33-foot long barrel can be checked completely within 0.0003-inch tolerance in just a few minutes. The distance from the muzzle end to the point where the diameter is being checked is also indicated on dials.

HIGH-SPEED TARGET

High-speed aërial targets have been ordered by Army Ordnance to aid in training Army troops in the operation of the Skysweeper gun and the Nike and other guided missiles.

The new targets, powered by Fairchild J-44 jet engines, fly at almost the speed of sound. They are remotely controlled from the ground and can maneuver at varying speeds and altitudes over anti-aircraft installations—simulating invading enemy aircraft.

PROTECT Spot-Welded and Hot-Riveted Assemblies from Moisture and Corrosion with . . . . . PITTSBURGH WELDSEAL TAPES!



YOU CAN'T GET BETTER PROTECTION against corrosion from moisture for the spot-welded and hot-riveted assemblies on many military and civilian products than Pittsburgh's Weldseal Tapes.

- **When applied** between members, these tapes flow around heated areas and throughout the seam to form a positive seal that is tightest around the shank of the spot or rivet.
- **Being mildly** conductive, Weldseal Tapes can be used with standard welding equipment, without causing spark or sputter. Their adhesive qualities permit ready application to all reasonably clean metals.
- **Weldseal Tapes** are available in three thicknesses – .015", .025" and .060", and in any width from ½ inch to 12 inches.
- **Samples of these** remarkable tapes are available for experimental work. Our engineers will also be glad to consult with you on sealing problems without cost or obligation.

Pittsburgh Also Offers Nu-CHROMSEAL And FABSEAL Tapes

- **Nu-Chromseal** is a solid, pliable compound in a film of fixed thickness for sealing lap joints or butt seams in metal, wood or fiber.
- **Fabseal** is an impregnated fabric for sealing between metal, wood or fiber members.

• • •

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PITTSBURGH PLATE GLASS COMPANY

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New Developments

Officially designated the XM21, the new air target looks like a "pint-size" fighter plane. It is built by the Ryan Aëronautical Company in San Diego. It has swept-back mid wings and tail surfaces and is approximately twelve feet wide and eighteen feet long. It will weigh about 1,800 pounds. The design incorporates a 2-stage parachute-recovery system to lower each target without damage after a target run.

SWINGING BOMB DOOR

Development of a new preloaded bomb door, which rotates 180 degrees just prior to bomb release and leaves no open bomb bay for buffeting winds, has been revealed by the U. S. Air Force's Air Research and Development Command and the Glenn L. Martin Company, Baltimore, Md.

Bombs in position on rotating door.

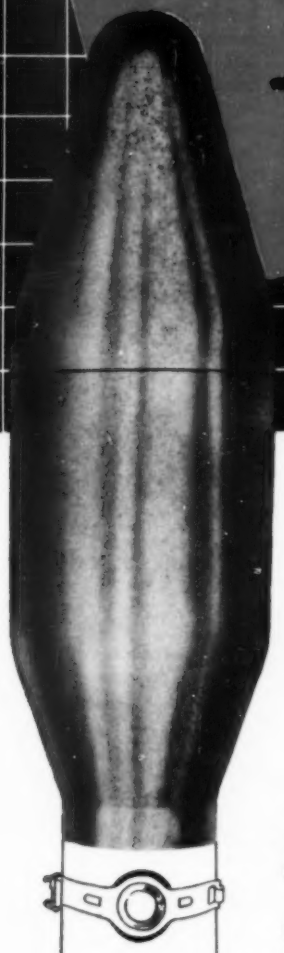
Through use of this door, a jet bomber traveling at today's high speeds is just as stable a platform as one flying at World War II speeds, and U. S. military aircraft will not have to slow down to make a successful bomb or rocket release as they have in the past.

Martin engineers developed the door as a part of the Martin XB-51 three-jet tactical bomber, and all tests have been conducted on that model. The XB-51 is now being used at the Air Force Flight Test Center, Edwards, Calif., to obtain high-speed bombing data. The door is removable from the airplane. When out of the airplane, it is mounted on wheels, loaded, chocked, and the bombs fuzed. It is then wheeled beneath the airplane and hoisted into position by using three standard bomb hoists.

NEW CERAMIC PROCESS

Air Force scientists have developed a new technique for the stabilization of zirconium dioxide, a material capable of withstanding temperatures over 4,000 degrees Fahrenheit, according to the Air Research and Development Command. The technique will enable the use of new fabrication methods, thus reducing manufacturing costs and making possible new utilization of this high-temperature ceramic material which will play an important rôle in developing rockets, turbo-

Business End of a Tank Killer



You are looking at one of the most formidable of tank killers, a 3.5" "Super Bazooka" Rocket Head of the type that helped turn the tide of Red tanks in Korea back in 1950.

Eastern Tool & Mfg. Co. designed and developed the tools, dies and manufacturing processes so necessary to the quantity production of various vital component parts of this rocket head.

We are proud to have played an important part in getting the first of these Rocket Heads to the front in Korea, when they were so desperately needed and to have contributed of our knowledge and efforts to help other manufacturers to get into similar production.

Eastern Tool & Mfg. Co. is currently producing many types of ordnance components, in addition to those of the 3.5" Rocket Head, shown at right.

Eastern Tool & Mfg. Co.
Belleville 9, New Jersey

Wire Forming • Metal Stamping • Deep-Drawing

Everything's Under Control with DRIVES and TRANSMISSIONS

by BREEZE MARK

90° ACTUATOR DRIVE
For direct connection to actuator that pivots in trunion mounting

TORQUE TUBE DRIVE
For transmitting torque between torque tube and flexible shaft

90° DRIVE
Precision gearing, double ball bearing suspension Sealed and lubricated

TEE DRIVE
Precision geared for actuators connected in series

■ To actuate tabs, flaps, shutters and other aircraft mechanisms with positive, precision control, the industry long has relied on Breeze drives and transmissions. From simple mechanical drives and direct reading indicator drives to electrical and hydraulic actuators, Breeze offers a complete line, affording a wide choice of components and assemblies to meet many individual design needs.

Shown here are examples of Breeze-engineered lightweight mechanical drives, having connections to mate with flexible shaft drives. The 90° and TEE drives may be mounted in any position with relation to an actuator mounting.

Inherent in all these designs are features dictated by specific aircraft needs and experience. You may find the assemblies you require in our wide variety, thus saving design and tooling costs. Or, our engineers will design and custom build to your special requirements.

We invite consultation. Write for our complete informative catalog.

OTHER BREEZE PRECISION PRODUCTS

Special Electrical Connectors
Electro-Mechanical and Hydraulic Actuators
Ignition Shielding
All Types of Flexible Metal Tubing
Aero-Seal Worm Drive Hose Clamps

BREEZE CORPORATIONS, INC.
41 South 6th Street, Newark 7, New Jersey

New Developments

jets, and high-temperature metallurgical research.

ROBOT SCANNER

An automatic electronic temperature-monitoring system designed to eliminate engine shutdowns due to bearing burnouts has been developed by industry for the Navy. A number of new systems are being produced under a contract with the Bureau of Ships. Heart of the automatic system is an electronic scanning instrument capable of checking temperatures in forty critical locations (usually in the turbine areas) every ten seconds. If the scanner detects an unsafe temperature at any point, an alarm sounds and a light glows on the instrument face pinpointing the trouble spot.

NEW PICKET PLANES

Flying radar stations, new high-altitude reconnaissance aircraft bulging with electronic detection apparatus, are in production for both the U. S. Air Force and Navy at Lockheed Aircraft Corporation. The craft are designed to carry the mili-

The new Lockheed radar airplane.

tary services' most powerful search radar to high altitudes where radar beams attain their maximum effectiveness in spotting either surface or air targets.

Announcement that production is under way was the first official report that the Air Force as well as the Navy has ordered picket planes. The new defense weapons will be special versions of the Lockheed Super Constellation transport model powered by turbo-compound engines and capable of long range, long endurance, and high altitude.

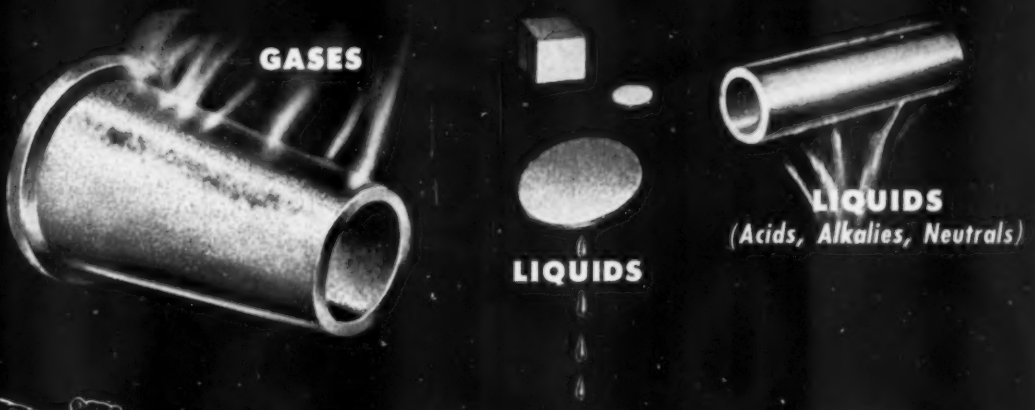
CLIMASTAT SUIT

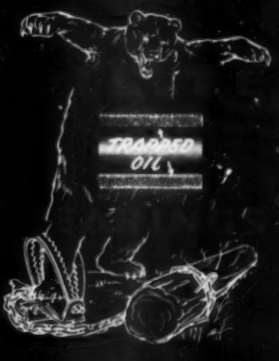
An experimental type of cold-weather clothing based upon a new principle of self-regulating temperature control has been developed by the Army Quartermaster Corps and will be tested in the Arctic. Currently designated the "Climastat suit," the new clothing represents an adaptation of the recently developed Coldbar suit but is designed to give protection under a much wider variety of cold-weather conditions than afforded by the latter.

In the Climastat suit there are two layers, each one-eighth inch thick, and each layer is perforated with numerous one-eighth-inch holes. The two layers are stitched together at all pattern edges and

OILITE
Permanent METAL FILTERS

Oilite PERMANENT FILTERS Provide:





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Amplex Division, Dept. G
DETROIT 31, MICHIGAN

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Oilite Products Include: Bearings, Finished Machine Parts, Cored and Solid Bars, Permanent Filters and Special Units 6433

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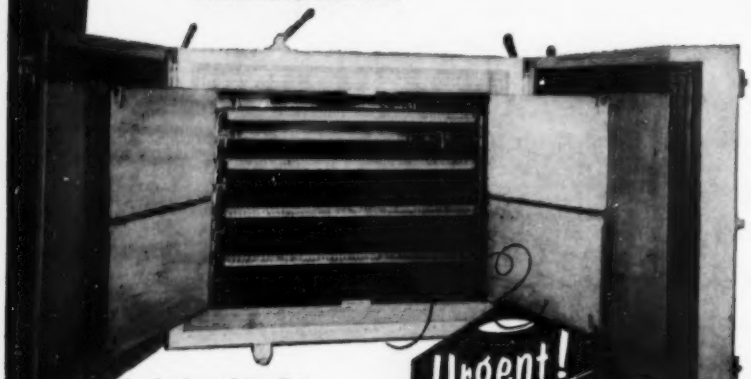
"EXPEDITED ENGINEERING"

pays off for

JEFFERSON PROVING GROUND

Madison, Indiana



Chamber for studying effect of various temperatures on behavior of ammunition.

SPECIFICATIONS

Temp. Range: —100°F. to 200°F.
Pull-down: 90°F. to —70°F. in 45 min.
Dimensions: 5' W. x 4' H. x 9' D.
Power: 115-volts, 20 amps.
Weight: 3350 lb.

Urgent!

8 units needed. Deliver first 2 in 60 days.

Tenney DELIVERY: Total order in 55 days!

The problem was urgent: The Army Ordnance Corps needed — *fast* — eight "conditioning boxes", in which Artillery ammunition could be subjected to extreme hot-and-cold temperatures before being test-fired at Jefferson Proving Ground. These chambers had to meet all the requirements — had to be shockproof — had to be completely portable. And TENNEY had to design, build and deliver the first two units within 60 days!

Tenney engineers designed a unit using dry-ice coolers, electric heaters, air circulation and precise thermostatic controls. Construction was rushed and completion of the first unit showed that performance far exceeded contract specifications — pull-down was held at —70°F. for 18 hours with no additional dry ice. Then production rolled . . . and the Army received *all 8 units 5 days before the first 2 were due!*

This is typical of Tenney's "Expedited Engineering," a policy based on years of meeting and solving problems in the design and construction of precision refrigeration, heating, and environmental test equipment. With this background, and manufacturing facilities keyed to meet all possible conditions, exacting specifications are speedily translated into well-engineered equipment . . . and delivered *on time.*

Testing troubles? Talk 'em over with

Tenney ENGINEERING, INC.

Dept D 24 AVENUE B, NEWARK 5, N. J.

Plants: Newark, N. J., Union, N. J., and Baltimore, Md.
Los Angeles Representative: GEORGE THORSON & CO.
Engineers and Manufacturers of Automatic Environmental Test Equipment

New Developments

are so arranged that the holes in one layer do not coincide with the holes in the other layer.

By using two layers of plastic insulation with staggered perforations the wearer is kept warm while inactive by an air seal surrounding his body. When the wearer is active, a forced pumping action results, providing ventilation through the holes and ridding the body of excessive heat and moisture. Water-repellent outer jacket and trousers prevent the entrance of outside moisture from rain or snow.

NEW LANDING DEVICE

The lives of Navy jet pilots and the complex and costly aircraft they fly are being safeguarded by a new electronic device that "clocks" an approaching airplane and indicates whether or not it is coming in at a safe landing speed. Installed on the carrier, the device "watches"

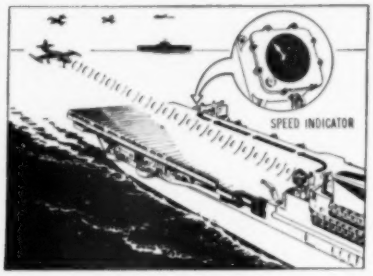


Diagram shows use of landing device.

the approach of an aircraft coming down for a landing and warns the landing signal officer if the plane's speed is too fast or too slow. The officer then wigwags his orders to the pilot, either guiding him down to a landing, or waving him off for another try.

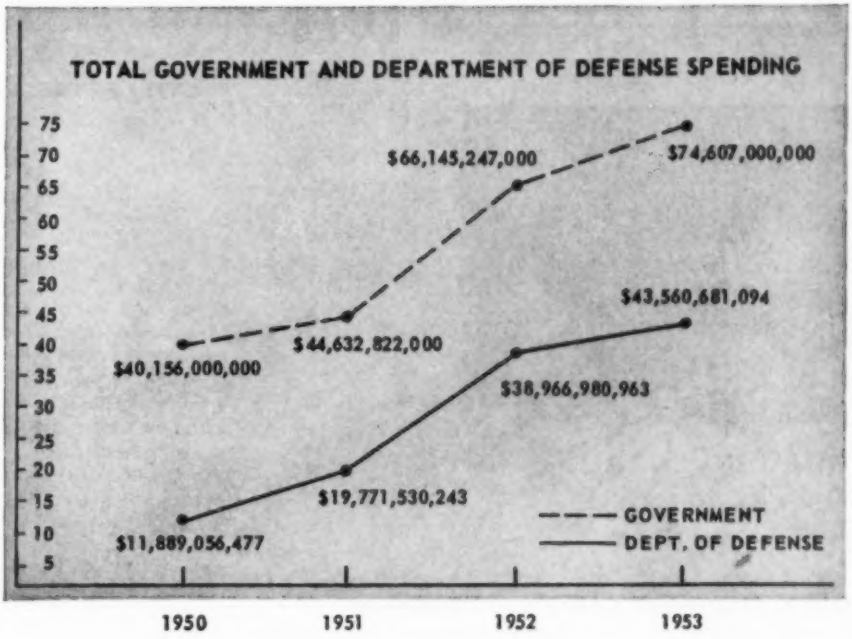
The new speed-measuring equipment automatically takes into account the speeds of the aircraft and the carrier and coordinates this information with the wind's speed to give an accurate and reliable reading of the true airspeed of the airplane.

NEW NAVY AIRSHIP

Defense perimeters of the United States will be strengthened in the near future with addition of the Goodyear ZP5K airship to the United States Navy's antisubmarine warfare team. A prototype model of the airship is now being built at the Goodyear Aircraft Corporation, Akron, Ohio.

The ZP5K is equipped with the latest developments adaptable to such aircraft for the purpose of detecting, locating, and attacking enemy submarines in the event of future war. The airship can refuel in flight from surface craft, and reballast by

THE DEFENSE PICTURE!



WHAT ARE THE ARMY'S PLANS? WHAT ARE THE NAVY'S PLANS? WHAT ARE THE AIR FORCE'S PLANS? HOW MAY INDUSTRY PLAN?

These and other pertinent questions are discussed by the editors of ORDNANCE in the recently published brochure . . .

THE DEFENSE PICTURE FOR 1954

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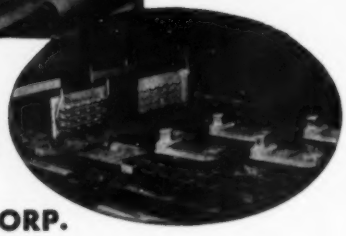

BRAZING TRAY life increased 140%
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Rolock "Serpentine" furnace trays, built for this specific use, were furnished in two sizes . . . 24" x 30" (weight 22 lbs.) and 24" x 36" (26 lbs.). The maximum load carried by the larger tray is 80 lbs. . . . in brazing, an exceptionally good ratio of load to weight. Some trays are of type 330 stainless, others are of Incoloy.

Trays formerly used had a maximum life of 2500 trips thru the furnace. Rolock trays give a minimum of 6000 trips . . . then are rebuilt for additional service.

Former trays required maintenance by one full-time skilled worker and a part-time helper; "Serpentine" have required absolutely no maintenance. Moreover, other trays frequently jammed in the furnace, causing costly down-time of the whole line. "Serpentine," no jamming, no down-time.

The answer, of course, is in the fully articulated "Serpentine" construction which resists warping to the highest degree. If this is one of your problems, write Rolock for practical solutions.

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New Developments

a water pickup system while under way.

The blimp's envelope will be made of Neoprene-coated cotton. Power plants will comprise two radial air-cooled engines, conventionally mounted on outriggers, which will drive two 3-bladed, full-feathering, controllable-pitch, reversible propellers. Both engines will be accessible for repair and service while in flight, if necessary.

FLEXIBLE CIRCUITS

A new method of producing flexible electronic circuits, as contrasted with rigid etched or stamped circuits, was described recently by E. R. Bowerman and R. F. Walton of Sylvania Electric Products, Inc., Bayside, N. Y. The new flexibly mounted circuits consist of thin layers of copper, in the desired configuration, attached to a woven cloth by a thermosetting adhesive. One of the important advantages of the flexible circuit is that it may be attached to rigidly fastened components whose connecting terminals may have large dimensional tolerances.

The production of the flexible plated circuit consists in silk-screening an insulating lacquer in a suitable pattern onto a stainless steel plate, copper plating the exposed areas of the steel, and stripping the plated copper and the insulating lacquer from the steel surface by an adhesive tape.

WRIST RADIO

An experimental wrist radio which is able to pick up broadcasts within a range of forty miles has been developed by the Signal Corps as a means of further exploring the possibilities of miniaturization. Dubbed the "Dick Tracy," the miniature receiving set is contained in a plexiglass case 2 inches long, 1⅛ inches wide, and ¾-inch thick. Its size is made possible through replacement of the conventional vacuum tube with five tiny transistors.

In addition to the advantages gained from the small size of the transistors, their low power requirement makes it possible to power the set with a mercury battery little larger than the tip of a pencil. The "wiring" in the chassis is made up of printed circuits.

NEW JET ENGINE

The Navy and the Westinghouse Electric Corporation have announced that Westinghouse has developed and placed in production a new high-power, low-weight turbojet aircraft engine known as the J46. Designed for use in high-speed military fighter planes, the J46 engine will be first used in the new swept-wing, tailless Chance Vought F7U-3 Cutlass, one of the Navy's latest high-speed carrier-based fighters.

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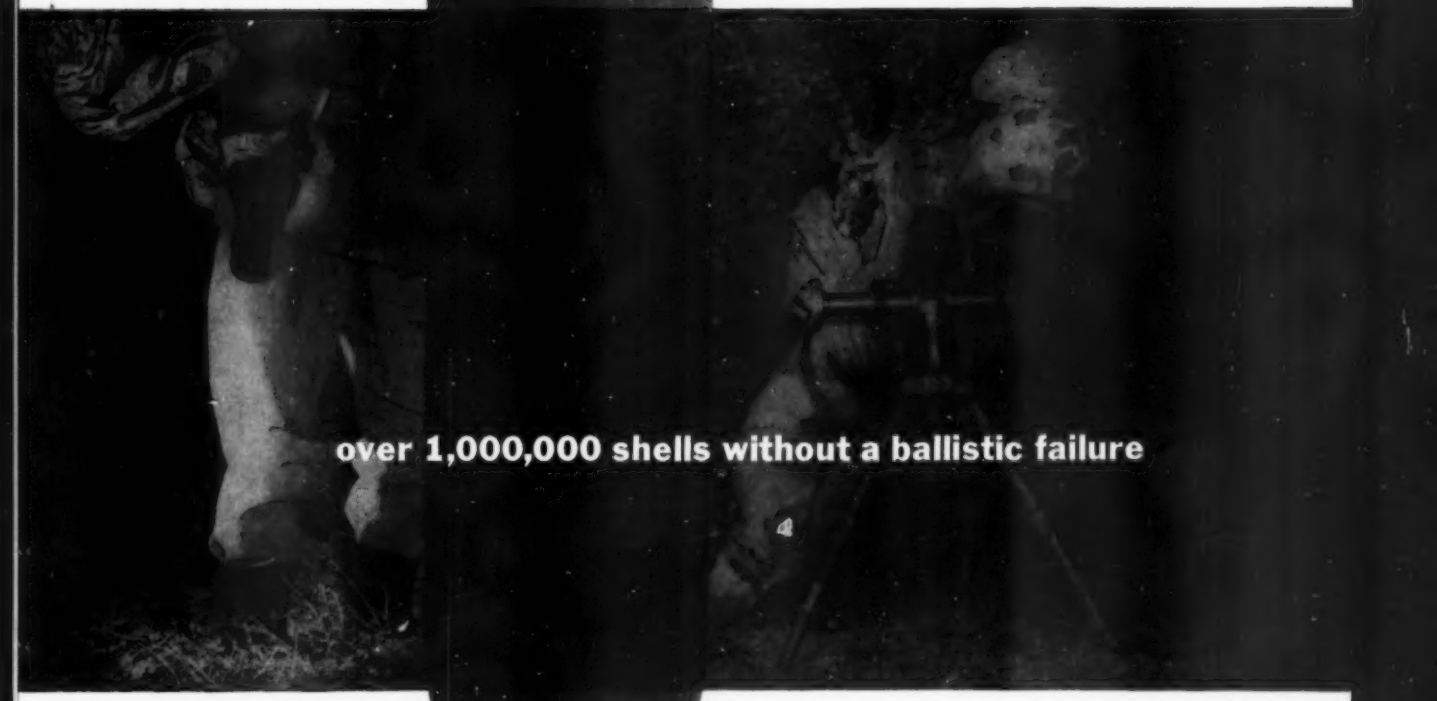

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Defense Division, Kwikset Locks, Inc., Anaheim, California

Rockwell Report

by **W. F. ROCKWELL, JR.**
President
Rockwell Manufacturing Company

DURING HAPPY TIMES of expanding sales, there is a tendency not to look too critically at sales expense. Only when the sales curve drops downward does the high-flying expense curve become unpleasantly obvious. Then steps are taken to bend it down. But there has been a time lag, sometimes a considerable one, during which profits are eaten up.

We follow a method that—we've been told—is not yet widely used. We maintain a continuous study of sales *cost* as well as sales volume. Each month sales cost as well as sales volume figures are analysed, compared, charted. As soon as a gap appears between them—with the sales curve on the lower side—we know that sales costs, in relation to volume, must be trimmed. Of course some time lag is still inevitable, but in our case it is very slight, and the savings are considerable.

We've been maintaining this continuing sales cost-sales volume study long enough to know that it pays; perhaps the idea may be helpful to others, too.

* * *

While there is nothing new about controlling the environment for a single department or a single operation, we believe our new valve and meter plant soon to be opened in Sulphur Springs, Texas, will be one of the few *completely* air-conditioned manufacturing plants in the nation. Except for the offices, it is windowless, enabling us to control the light, as well as the atmosphere, in which to perform close tolerance manufacturing operations.

* * *

It must be obvious now even to the most skeptical that the mushrooming "do it yourself" boom is not a passing fad. People will continue to paint it, fix it, or make it themselves—for two good reasons. One is economic: it costs more than most people can afford to hire skilled workers to do "handy man" jobs around the house. The second is spiritual. Nothing quite equals the warm glow of satisfaction that comes when you look proudly at something you, yourself, have fixed or built. Folks are finding out it's fun to "do it yourself." Sales of our DeltaShop and other Homecraft tools are continuing at a very pleasing pace.

* * *

Our Register Division pioneered toll bridge and toll road collection practices. Their Ohmer Toll Recording and Indicating Systems have been installed on many of the country's leading toll facilities. The latest models incorporate some unusual features that assure fast, accurate collections of various classes of tolls with minimum hinderance to traffic while, at the same time, providing maximum control over revenue.

* * *

We've always thought of ourselves as being in the manufacturing business exclusively. So it was something of a surprise the other day to realize that as a by-product of manufacturing, we are also in the publishing business in a sizable way. With a circulation of over 40,000, *Flow Line*—a publication of our Meter and Valve Division for the oil, gas, chemical and industrial fields—exceeds the circulation of the outstanding trade magazine in its field. The *Water Journal*, published for men concerned with water supply and sewage disposal, has double the circulation of any book in its field. The Deltagram brings "how to do it" information to more than fifty thousand home workshop enthusiasts, who pay a subscription fee of one dollar a year.

One of a series of informal reports on the operations and growth of the
ROCKWELL MANUFACTURING COMPANY
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for its customers, suppliers, employees, stockholders, and other friends

COMMUNICATIONS

SHEARING FOR EXTRUSION

THE EDITORS.—The advent of cold extrusion of steel broadens the vistas in the field of metalworking. This new process already has successfully demonstrated its usefulness and its many attendant advantages, both in Ordnance and domestic requirements.

As is usually the case, each new metalworking process calls into being new tools and new machines to perform the required operations. Entirely new and better machines must be designed, and many existing machines must be improved. Such a tendency is already reflected in the activities of many machine-tool builders.

One of the first requirements in choosing necessary equipment for a cold-extrusion plant is to consider the most suitable method of cutting blanks from billets. The majority of steels used for cold extrusion range in the low-carbon series, such as C-1010, 1018, 1020, and 1028. These are easily workable steels and are therefore relatively easy to cut into blanks.

By the same token, squareness and smoothness of the cut are necessarily important factors that have a direct bearing on the success of the subsequent extruding operations. In the case of some steels it is necessary to stress-relieve the material by annealing. This is especially true of the higher-carbon steels.

With these requirements in mind and also remembering that cold extrusion aims at making great savings, the most efficient method of producing blanks and the one that saves the most metal is the most desirable. From the standpoint of speed, producing the most blanks per hour at the lowest cost per cut, shearing has no equal. Operational and maintenance costs of shearing equipment are also the lowest.

The squareness of a sheared blank has long been a debatable issue, but it is only because of a growing need in the forging industry that this desired condition of square blank ends has become a tangible reality. With upset and cold extrusion it is a "must."

The solution that produces the required perfection in this respect can best be designated as the "confined-cut" method. The confined-cut development, however, could not be a success by itself alone. Other attendant developments in shear design and other accessories make it a practical and workable feature. Through the use of these new features scrap cuts can quickly become a thing of the past.

WILLIAM C. TUCKER
Buffalo, N. Y.

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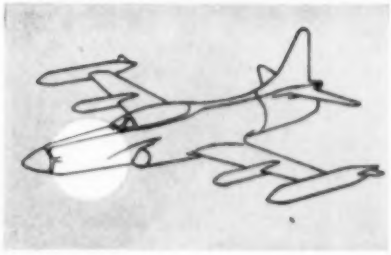

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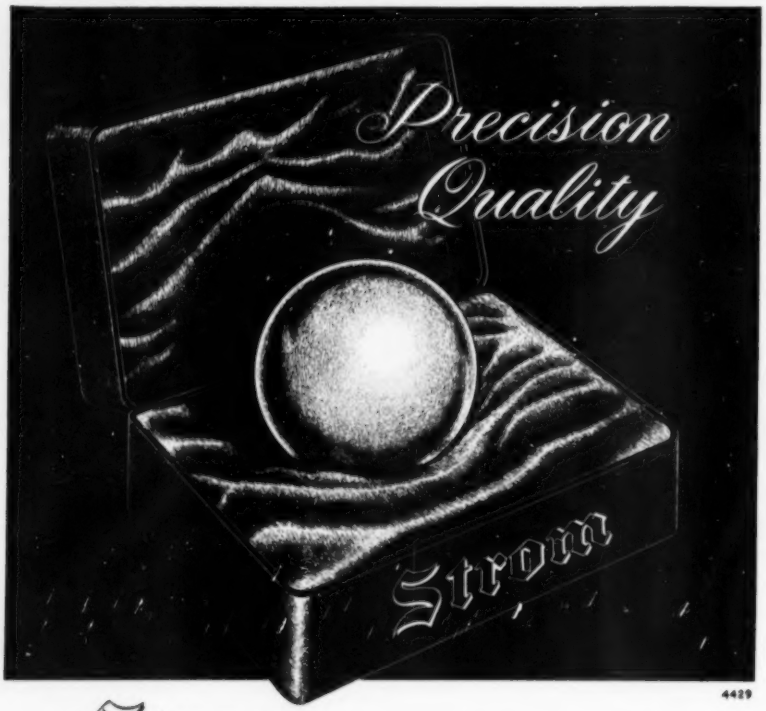

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FROM THE RECORD

TRENDS IN AIR POWER

MAJ. GEN. JAMES MCCORMACK
Vice Commander, Air Research and Development Command, U.S. Air Force

Air power is going to be continuously and increasingly more atomic in its many aspects. The miracles that have happened thus far during the first dozen brief years of the atomic age are only the beginning. They have not all been American miracles, nor will they be in the future.

Secondly, military air vehicles are going to move on out into the supersonic region to speeds many times that of sound.

Thirdly, weapons will continue to become more and more automatic in operation through the use of electronic, sonic, infrared, and other techniques.

Fourthly, we who practice the military art will be governed ever more forcefully, in our thinking and in action, by considerations not just of weapons but of weapon systems. . .

In the total air-defense system the fact is that no important element can be jiggled without jiggling the whole system. The time has passed when a proposed new weapon or other component could be judged on its own merits alone; it must now be looked at in conjunction with dozens of other equipments.

As regards jet bombers, the B-47 is a high-altitude medium bomber whose range can be extended by refueling. The B-52 has more altitude, more speed, more range. Its size is a direct reflection of the requirement for range, which is, of course, the basic requirement for a strategic system: above all else you have to be able to reach the target.

Considering costs, there is a limit to our ability to achieve range by increasing aircraft size. Also, one likes to present small targets to the hostile air defense. Therefore, as our technology improves, the trend should be toward smaller, higher-performance aircraft that will still have the range necessary to do the strategic job.

We Must Learn More

This will require that we learn more about aërodynamic and power-plant design and about materials and that we develop the most effective applications of the knowledge we have.

Electronic gear will be much improved, especially with the help of transistors.

It might be noted, parenthetically, that the electronics development problem is less one of theoretical quality than it is one of reliable performance in combat in the

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ND53

From the Record

face of enemy countermeasures. The best radar bomb sight, for example, is by no means the one that works most precisely on the bench. It is the one that works reliably and with satisfactory accuracy when the enemy is busy trying to put wrong answers into it.

In due course there will be nuclear propulsion for strategic and other air systems.

To supplement manned aircraft in not too many years, and eventually to replace them in substantial measure, pilotless vehicles will be developed for the strategic rôle.

In the early stage of this art, where we find ourselves today, there are difficulties, as in automatic devices for navigation and final control to the target, which make the manned aircraft still by far the most practical solution.

Systems Will Improve

These deficiencies will be cured in time, and mechanical systems will have accuracies equaling or bettering the precision of our present knowledge of where the point on the earth's surface decided on as the target actually lies relative to the launching point. In this connection there is room for improvement in mapping techniques as well as in strategic reconnaissance generally.

Among other obviously fertile technical fields for investigation, including fundamental investigation, are (1) the nature of electromagnetic radiations in the outer atmosphere and beyond, and (2) power plants having the thrust and endurance which will be required for high supersonic speeds over great distances.

These samples will indicate that the total technical job for strategic air is quite a bill of goods—and it is. However, I would say that it is well within this country's capabilities during the course of the next generation, and possibly in a much shorter time, to bring forth strategic weapons systems against which an adequate defense cannot now be visualized.

The technical aspects of tactical air are in large part the same as those of strategic air, as we have just discussed them.

Awesome Capability

For example, developments in atomic weapons have long since given fighter aircraft, such as the F-84, an awesome capability for massive destruction. Furthermore, fighter ranges are very impressive in terms of any potential area of land battle.

We need, and will have, fighter-bombers and day fighters that are fast, reliable, and able to operate from forward areas.

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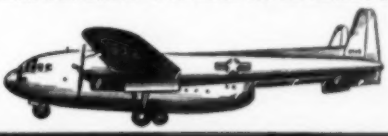

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From the Record

The F-100, our latest production day fighter, is designed to give tactical air a supersonic capability.

A new night intruder, the jet-powered B-57, is beginning to roll off the production line.

Reconnaissance is one of the most important tasks of tactical air warfare. An outstanding job has been done in Korea with present equipment, but the equipment now in development, such as the RB-66, will greatly improve our present reconnaissance capability.

Aircraft ground control systems are essential to effective conduct of the tactical air battle. They are not as complex as those needed for continental air defense, but they are still not simple, and we must improve what we now have.

Many targets for tactical air are of a relatively fleeting nature. This imposes a requirement for equipment of great flexibility in action as well as simplicity, and the two are not always synonymous.

Tactical Missiles

Pilotless aircraft and guided rockets are coming along for the tactical rôle. It is not yet clear just how much of the mission they can take over, or on what schedule, but they can surely do a substantial part of it.

The ground electronic environment for the defenses of the United States is being improved and will continue to be improved through the years immediately ahead. We need to continue to raise the level of our technical competence in the design, installation, maintenance, and operation of the equipment that is involved.

As regards early warning, to which much publicity has been given during the past year, and the system for tracking and enabling the interception of hostile flights, the trend is quite clear. It is toward the use of larger numbers of small radars to give more reliable coverage of the air space at all altitudes. The total system will be much more automatic and will be able to handle much larger numbers of aircraft than is now possible. You are all aware of the major effort under way by Project Lincoln for the development of such a system.

The current inventory of first-line interceptors is being built around high subsonic, all-weather types: the F-86D, F-89, and F-94.

Air-to-air rockets, including guided rockets, will become standard interceptor armament, and ground-to-air missiles are well along in development.

As bomber performance improves, so also must the performance of air defense weapons. The delta-wing F-102 will constitute a major step into the supersonic region for interceptors.—*From an address before the Air Force Association National Convention, Washington, D.C.*

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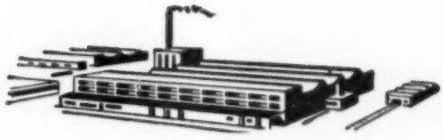

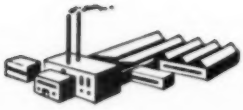

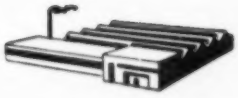

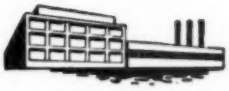

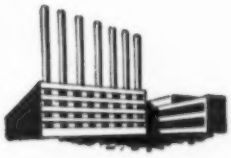

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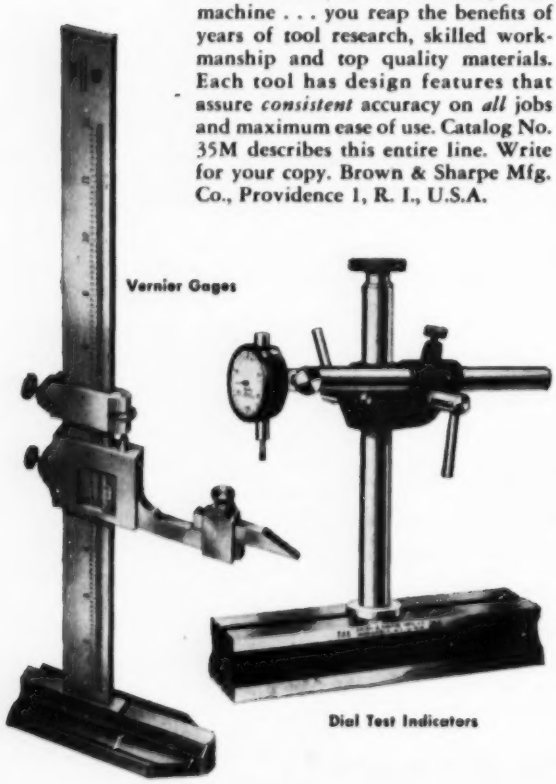

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Atomic Weapons in Land Combat. By Col. G. C. Reinhardt and Lieut. Col. W. R. Kintner. Harrisburg: Military Service Publishing Company. 182 pp. $3.95.

IN the eight years which have elapsed since the atomic bomb first amazed and terrified the civilized world, much has been written. Most of this has been of atomic effects on civil populations, and much of it has been quickly done, consisting largely of speculation and "dramatics."

The authors of the present volume have adhered closely to their purpose—a carefully prepared study of the atomic weapon against land combat forces.

After separate work on the subject, one at the Industrial College of the Armed Forces and one at the Graduate School of Georgetown University, they met at the Army's Command and Staff College. Assigned to a group on the study of modern weapons, they soon expanded their work to partnership with other military organizations, yet specialized in consideration of the tactical use of atomic explosives.

The study steers a course between the Scylla of terror and the Charybdis of indifference. Factual in the extreme, the authors, being aware of the complete lack of actual battlefield experience, were the more cautious to check and recheck every known result of atomic explosions. Effects in every type of tactical warfare problem are carefully considered with logical

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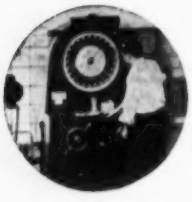

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Book Reviews

and, so it seems to this reviewer, quite sound conclusions.

Some twenty-five drawings, maps, and charts illustrate the work, and a 12-page appendix furnishes ready reference to definitions and tables of distance, casualties, and the like.—F. W. Foster Gleason.

Marines in the Central Solomons. By Maj. John N. Rentz, USMCR. Washington: U. S. Government Printing Office. 186 pp. $2.75.

The Campaign on New Britain. By Lieut. Col. Frank O. Hough, USMCR, and Maj. John A. Crown, USMCR. Washington: U. S. Government Printing Office. 220 pp. $3.75.

WHATEVER the United States Marines do they do well. The record of their campaigns in the Second World War is written deep in the hearts of the American people as indeed are their exploits from the very beginning. These two books are the products of the Historical Branch, United States Marine Corps, and are all that the military historian could desire for the permanent record of the strategy, tactics, organization, and personnel which contributed so notably to the respective campaigns.

"Marines in the Central Solomons" is the work of Major John N. Rentz, USMCR, and is the tenth in the series of monographs.

In the words of Gen. Lemuel C. Shepherd, Jr., Commandant of the Corps, the Central Solomons area by early 1943 "might be described as an amphibious no man's land lying between Rabaul and the new Allied citadel of Guadalcanal, across which the two antagonists exchanged air and naval blows."

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"The Campaign on New Britain" by Lieut. Col. Frank O. Hough, USMCR, and Maj. John A. Crown, USMCR, are of the same format and treatment as "Marines in the Central Solomons" and the other volumes in the series of Marine Corps monographs. New Britain cost the Marine Corps the lives of more than 300 of its members. Here was jungle warfare at its worst. "Jungle, swamp, and mountain combined with atrocious weather to multiply problems of time and space."

Again from the standpoint of clarity of description, illustrations, maps, and supplemental data "The Campaign on New Britain" is military history as it should be recorded.—L. A. Codd.

The Original Confederate Colt. By William A. Albaugh, III, and Richard D. Steuart. New York: Greenburg, Publisher. 62 pp. $5.

HE who can afford to pay eight cents a page for his gun books and isn't overly particular as to what he gets for his money will find this beautifully printed little volume (not little in format, measuring as it does 7¼ by 10½ inches) an interesting addition to his material on Confederate small arms.

But when one comes to appraise the text, he wonders whether it adds much of value to the matter set forth on pages 266-272 of Fuller and Steuart's "Firearms of the Confederacy" (Standard Publications, Huntington, W. Va., 1944) as supplemented by Albaugh's article, "Confederate Handguns," in Ordnance (Vol. XXXVI, pp. 493-501, November-December 1951).

The presumptive *raison d'être* for this volume is a desire on

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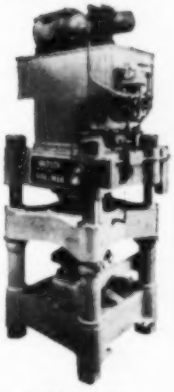

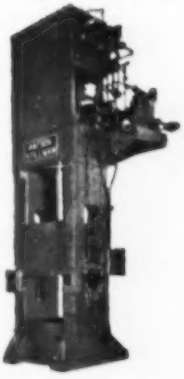

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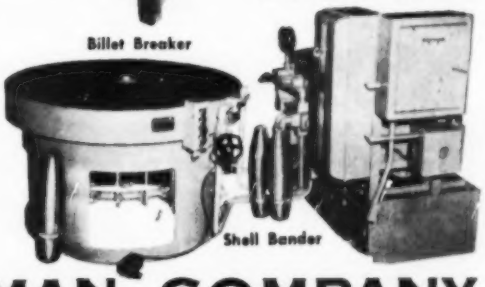

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Book Reviews

the authors' part to establish the revolver made by Messrs. Leech & Rigdon and successor companies as the *first* Colt-type handgun to be produced for the Confederacy—the "original Confederate Colt" of the book's title.

However he fails, in my opinion, to make a case. For although he shows that Leech and Rigdon were operating as a firm in Memphis as early as March 1862, moving later that year (May 9th) to Columbus, Miss., he plainly indicates that they produced no revolvers at the first location and that their manufacture of any at the second remains definitely conjectural.

On February 2, 1863, the partners purchased a factory in Greensboro, Ga., establishing there sometime later that year. In this city they completed the first of their revolvers which can definitely be identified as to year (1863) and place of manufacture.

Yet we learn (p. 19) that about November 1861, Schneider & Glassick, Memphis gunsmiths, joined forces and secured a contract with the Confederate Government for the manufacture of "Colt" revolvers. Approximately fifteen of these were supposed to have been made prior to the fall of the city in June 1862.

And since their product was definitely of Colt type, it appears to me that the author has failed entirely to establish priority for Leech and Rigdon.

There were yet other makers of "Confederate Colts," some of whose arms certainly appear to have reached the market ahead of those of our author's fair-haired boys. First among these were Griswold and Grier of Griswoldville, Ga., a firm which Albaugh describes in his ORDNANCE article as turning out finished weapons "early in 1862."

Not far behind them were the Haimans Brothers of Columbus, Ga., who purchased a factory in that city in April 1862 and received a C.S.A. contract for 10,000 revolvers in August of the same year. Both these plants produced Colt-type handguns.

To me, the book, which borrows many passages from Fuller and Steuart's "Firearms of the Confederacy" without giving credit for any of these, is a distinct disappointment.—CALVIN GODDARD.

Sheridan the Inevitable. By Richard O'Connor. Maps by Wilson R. Springer. Indianapolis: Bobbs-Merrill Company. 400 pp. $4.50.

A COMPETENT military historian's account of a first-class fighter. Sheridan, like Grant, gave little promise by his prewar record. Like Grant, he considered fighting the one solvent of war, and, like MacArthur, he knew that there was no substitute for victory. Perhaps but a mediocre army commander, he was yet a genius of the attack and of the use of cavalry.

Author of biographies of George Thomas and John Bell Hood, O'Connor now gives us the best work of the three. Not only military students but Americans weary of "limited objective warfare" and its stalemate, will warm to this splendid account of a fighting American general.—F. W. FOSTER GLEASON.

Fatigue of Metals. By Dr. R. Cazaud. Translated by A. J. Fenner. New York: Philosophical Library. 334 pp. $12.50.

SINCE the start of the industrial revolution and the consequent development of a multitude of metal machinery, the occurrence of sudden, apparently unheralded metal fracture has plagued all concerned. It appeared to those first observers that metallurgical change, occasioned by the cyclic application of stress, had taken place. A normally ductile metal, capable of observable deformation before fracture under static conditions, had suddenly broken in a brittle manner, perhaps caused by "tiring" or fatigue.

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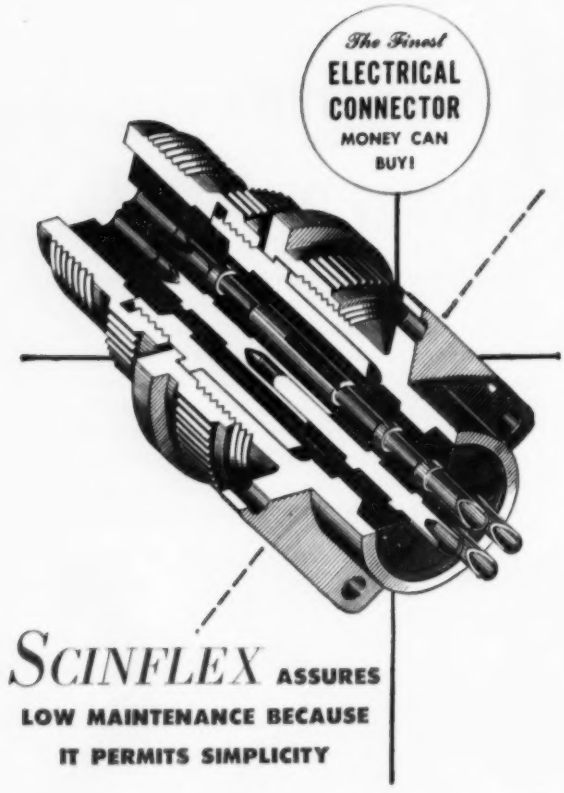

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the bulk of the reliable scientific research that has now become history to the present in the investigation of fatigue phenomena.

The first chapter is historical, brief but satisfying, for it establishes the general nature of the problem in the mind of the new reader and perhaps fills in some gaps for the specialist in this subject.

After the general nature of the problem is established, the author examines the observable events in detail and describes the characteristics of fatigue failures and equipment useful in their detection. With the reader thus well prepared, he again returns to history and presents in very concise style the many postulations on the mechanism of fatigue and theories to aid in rational design.

Because experience has shown that neither these postulates nor theories have provided the universal solution, experimental methods are very much in the foreground whether for the purpose of testing a theory or a structure.

The fourth chapter in the book is a well-written description of the European testing machines and experimental accessories, some of which are not well known in this country and hence are of special interest.

The next four chapters are devoted to the presentation of well-documented experimental data. They will serve as a reference for the characteristics of specific metals and also as general reference to the influence that factors such as stress-time state, size and shape, surface conditions, temperature, etc., have on fatigue characteristics.

While the text is not aimed at a discussion of the prevention of fatigue alone, useful conclusions are drawn and presented in the last two chapters to assist the designer and manufacturer in reducing failure by fatigue.

The documentation of this scientific text is excellent, and the extensive bibliography presented at the end of each chapter serves as a useful reference to the literature, particularly of Europe. There are sufficient entries of American literature, however, to indicate that the bibliography is useful in local scientific libraries.—J. H. FLANAGAN, *Watertown Arsenal Laboratory, Watertown, Mass.*

Medieval and Renaissance Arms and Armor. By Stephen V. Grancsay. Los Angeles: Los Angeles County Museum. 34 pp.

THE board of trustees and the directors of the Metropolitan Museum of Art loaned to the Los Angeles County Museum for exhibition from January 15 to March 18, 1953, a collection of its medieval and renaissance arms and armor. A catalog of these was prepared by Stephen V. Grancsay, curator of arms and armor at the Metropolitan and a distinguished member of the American Ordnance Association.

Mr. Grancsay is acknowledged to be our foremost expert in this field. His selection of items for display and his descriptions of them in the catalog are marked by the scholarship for which he is famed.

The net result of the exhibition as the catalog indicates was to stress not only the superb workmanship which went into the body armor, harnesses, and weapons of the Middle Ages but also their practical value in the designing of modern armor. With the help of Mr. Grancsay the revival of the use of armor on the battlefield has again come to the fore with amazingly good effect.

This catalog prompts the hope that other cities might be so favored by the Metropolitan and that Mr. Grancsay's genius might also be available to help bring about a wider understanding of the meaning of armor and armament in the conflicts of today as revealed by the conflicts of the past.—L. A. CODD.

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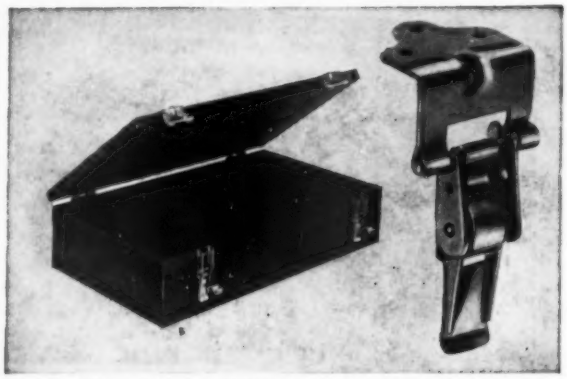

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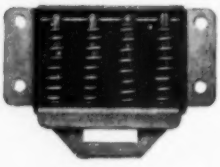

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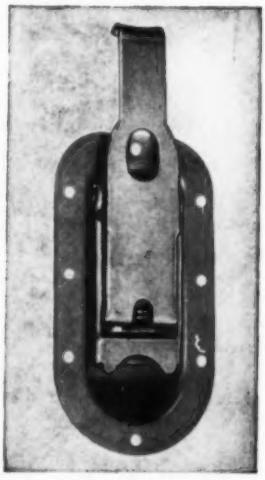

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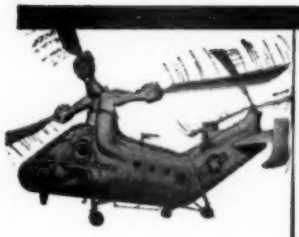
NAVY BUREAU OF AERONAUTICS
NEW IDEA FARM EQUIPMENT COMPANY
PIASECKI HELICOPTER CORPORATION
PIPER AIRCRAFT CORPORATION
PRATT & WHITNEY AIRCRAFT
RYAN AERONAUTICAL CORPORATION
SYLVANIA ELECTRIC PRODUCTS, INC.
THOMPSON PRODUCTS, INCORPORATED
U.S. ARMY ORDNANCE
WESTINGHOUSE ELECTRIC CORPORATION
WRIGHT AERONAUTICAL DIVISION
CURTISS-WRIGHT CORPORATION

"Sinews" to give cars "go"

For vital automotive parts—precision-machined components that can "take it," year after year, leading *automobile manufacturers like* FORD, *have long looked to Lycoming.*

"Blasts" for jets

To precision-produce tough, unfailing major components that put the "blast" in its superb J-47 jet engine—GENERAL ELECTRIC *looks to Lycoming.*



How a helicopter hangs by its "elbows"

For flexible "elbows"—rotor assemblies that control the amazing maneuvers of its H-21 "Work-Horse" Helicopter—PIASECKI *looks to Lycoming* for precision production.

New "ticker" for tanks

For a dependable tank "heart"—500 horsepower's worth of rugged, air-cooled engine—U. S. ARMY ORDNANCE *looks to Lycoming*, pioneer in the air-cooled engine field.

How a jet engine runs on its "nerves"

To produce the auxiliary "nerve center" for its J-40 jet engine—a complex gearbox that transmits power to vital accessories—WESTINGHOUSE *looks to Lycoming.*

"Air horses" for lifesaving over the sea

To help swell the production of the mighty Wright-Cyclone engine—dependable "horses" for air-sea rescue work—CURTISS-WRIGHT *and the* U. S. AIR FORCE *look to Lycoming.*

FOR RESEARCH • FOR PRECISION PRODUCTION

LOOK TO **LYCOMING**

Lycoming Spencer Division, Williamsport, Pa. AVCO Bridgeport Lycoming Division, Stratford, Conn.

AIR-COOLED ENGINES FOR AIRCRAFT AND INDUSTRIAL USES • PRECISION-AND-VOLUME MACHINE PARTS • GRAY-IRON CASTINGS • STEEL-PLATE FABRICATION

G.P.&F. Produces 1,000,000th Ammunition Box

The Sheboygan, Wis., plant of Geuder, Paeschke & Frey Co., recently celebrated the completion of the one-millionth .30-cal. ammunition box it is now producing for the government. Shown in the photo above are, left to right: William Livingston, Assistant Chief of Purchasing, Chicago Ordnance District; Frank T. Frey, G. P. & F. Executive Vice-President; Major E. A. Smith, personal representative of Colonel Haskell, Commanding Officer, Chicago Ordnance District; August K. Paeschke, G. P. & F. President; Major R. E. Ryan, Commanding Officer Milwaukee Regional Office, Chicago Ordnance District. G. P. & F.'s Sheboygan branch plant is devoted entirely to military production.

• Whether your requirements are for military use or civilian use—whether you need an ammunition box or a washing machine tub—if it's stamped or drawn, chances are that G. P. & F. can do it for you. When you think of G. P. & F., think of over 1000 skilled people . . . 15 acres of production facilities . . . 293 deep draw and stamping presses . . . 97 welding machines . . . a complete tool and die department.

METAL STAMPINGS FOR EVERY TYPE OF CIVILIAN AND MILITARY USE

Automobile Oil Pan
Hot Dip Lead Coated

Washing Machine Tub
Seamless Drawn—
Vitreous Enameled

Radio Case
U. S. Signal Corps

Base for Power Lawn Mower
Seamless Drawn Steel

Aerial Delivery Container
U. S. Air Force

Deep Fat Fryer Pot
Stainless and Carlson Steel

Scale Platter
Vitreous Enameled

Commercial Fruit Juicer
Stainless Steel

Tub and Cover for Portable Dishwasher
Seamless Drawn Aluminum—
Baked Enamel Finish

G.P.&F.

STAMPING • DRAWING • FORMING
WELDING • SPRAY FINISHING
VITREOUS ENAMELING • FIBER GLASS

GEUDER, PAESCHKE & FREY CO., 1327 W. St. Paul Ave., Milwaukee 1, Wis.

When "Keep Going" is a MUST

In combat the importance of completely dependable ignition cannot be overemphasized. Tanks and armored vehicles must advance despite hazards of terrain or enemy fire.

It is here that the Bendix Magneto Ignition demonstrates its inherent ability to "keep the engine going" under the most adverse circumstances.

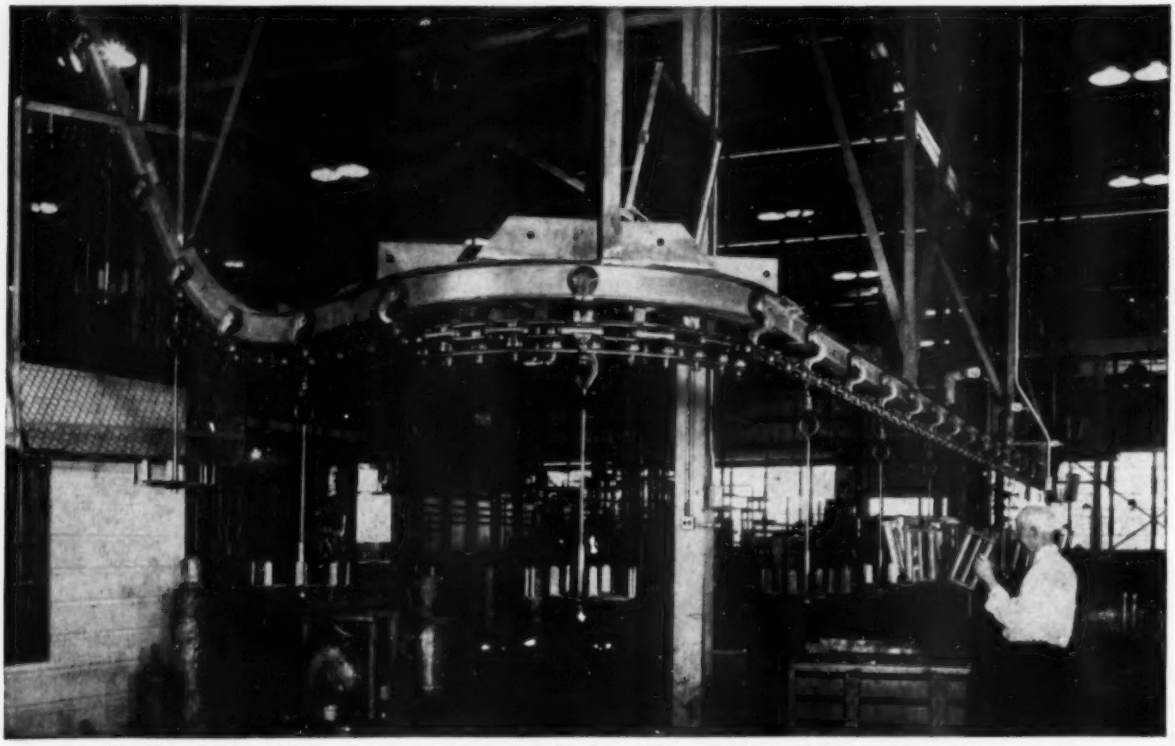
Bendix Magneto Ignition is an independent, self-sufficient system that places no demands on a normally loaded electrical system. It provides a hot spark at all speeds and minimizes fire hazard with elimination of supply leads. With Bendix Magneto Ignition, contact points and distributor electrodes have longer life because of inherent current reversal, and ignition is radio-shielded and water-proofed. Service, too, is far easier due to compactness and simplicity.

In fact, when "keep going is a must" Bendix Magneto Ignition is the unchallenged first choice.

Bendix

Bendix

How one Link-Belt Overhead Trolley Conveyor coordinates eight production operations



Link-Belt Overhead Trolley Conveyor makes 120° curve after descending to working level. Part assembly stations are at right.

LINK-BELT engineered system increases output per manhour 33%

How would you coordinate movement of parts to and from five furnaces and three assembly stations, each operating at different capacities? Here's what one company did:

They installed an 856 ft. Link-Belt Overhead Trolley Conveyor system. Immediately efficiency so improved that production became limited only by furnace speed. Valuable manpower was released for skilled tasks . . . floor space previously needed for parts storage was utilized for productive operations.

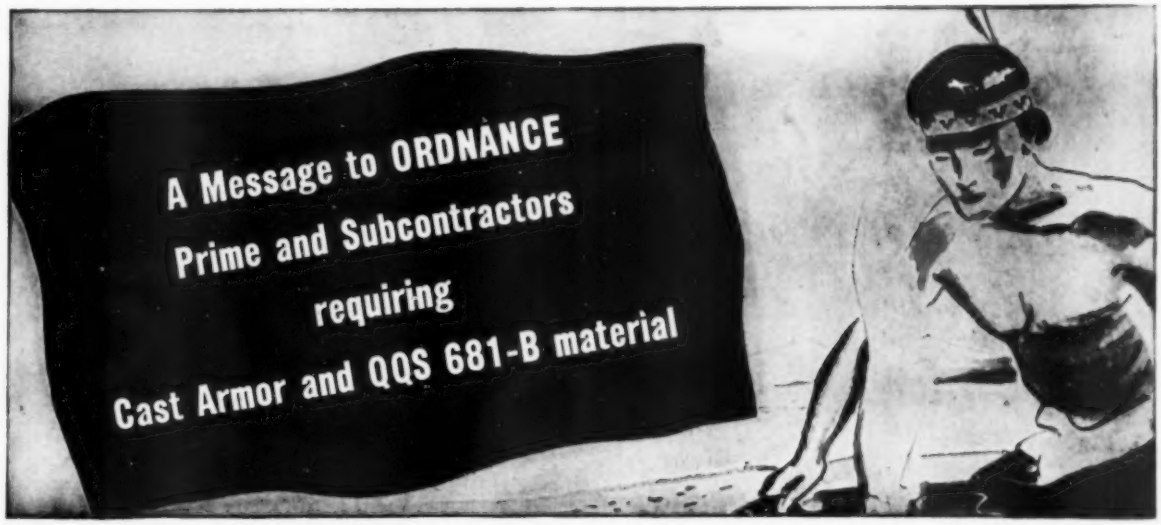
If materials move along a fixed route in your plant, Link-Belt Overhead Trolley Conveyors may offer similar benefits for you. Material can be moved upward, downward, to either side . . . kept close to the ceiling where headroom is required or lowered to bring it down to a working area. To learn what can be done to increase production in your plant, consult a Link-Belt engineer. Simply call your nearest Link-Belt office for expert, experienced assistance.

Conveyor takes 180° turn prior to bringing parts to two of the furnaces. Note spring type corner idler take-up. Building-to-building movement is also coordinated by this system.

LINK-BELT

OVERHEAD TROLLEY CONVEYORS

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices in Principal Cities. 13,271



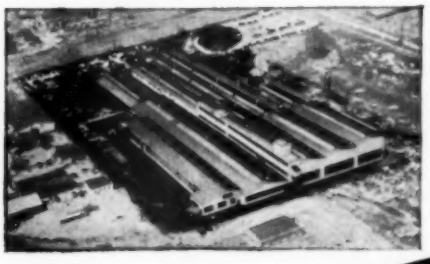
LET RIVERSIDE HELP SOLVE YOUR CASTING PROBLEMS

Riverside Foundry is ready to give you excellent service on cast armor and all types of QQS 681-B materials. *In fact, any steel casting specifications for which your contract might call.* We have a full staff of men who have spent years producing ordnance material.

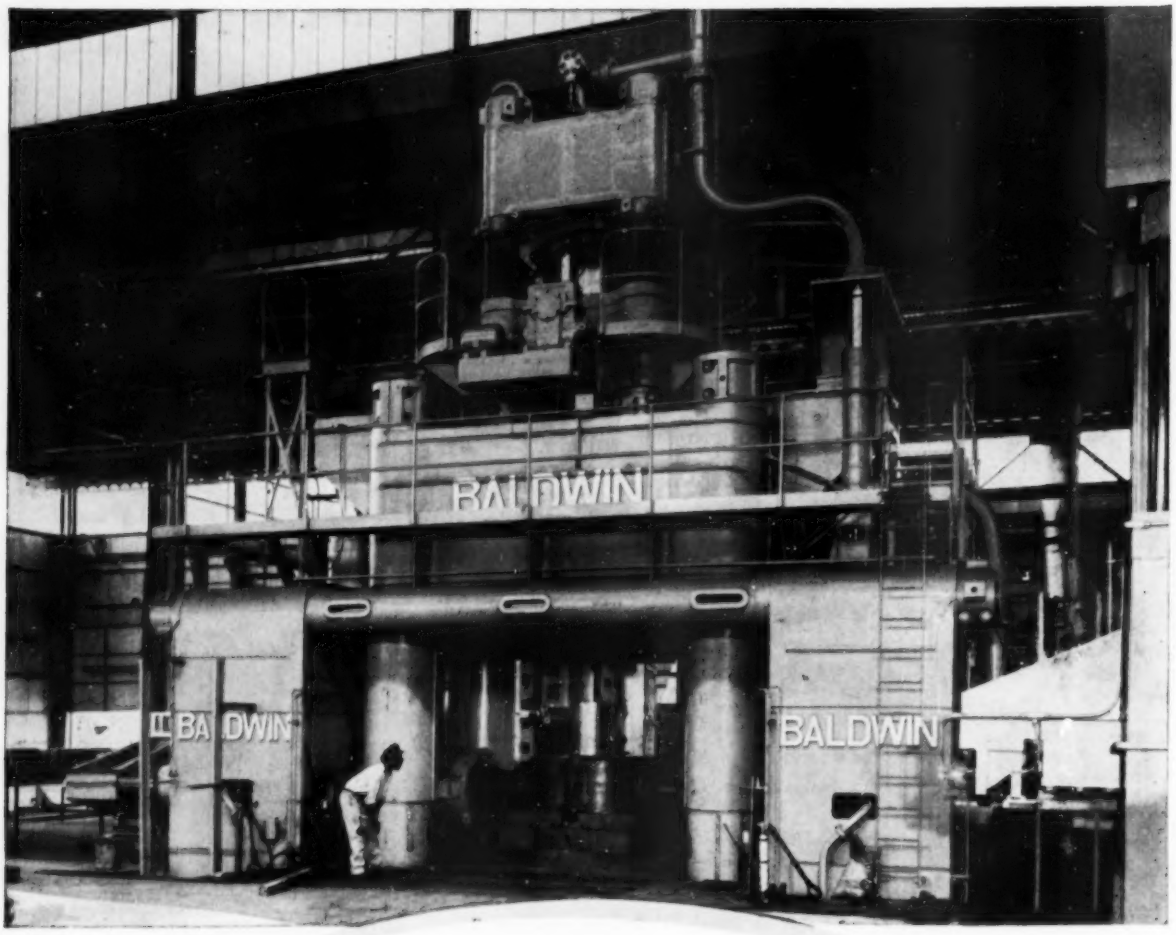
Our customers include many great names of American Industry: Chrysler, American Locomotive, International Harvester, Fisher Body, Ford Motor Company, Massey-Harris, and Rock Island Arsenal. *Ask them about Riverside.*

Call or write us at Riverside today.

For a dependable qualified source of steel casting requirements, see Riverside. You give us your drawings. The rest of the job is ours. Save yourself time. worry and loss of production. We are ready to do a complete job on any casting requirement.



The big modern Riverside Foundry at Bettendorf, Iowa has the best equipment to do the best job.



A NEW ERA IN STEEL FORGING

BEGINS IN HOUSTON

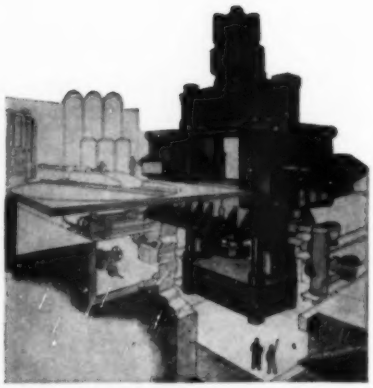
This new multiple ram forging press, the largest of its kind ever constructed, utilizes the Cameron Closed Die Extrusion Forging Process. The press forgings produced approach for the first time the broad field of intricate shapes that have been limited heretofore to steel casting. A new era begins in steel forging resulting in improved quality at a lower cost.

For further information write

FORGE AND ORDNANCE DIVISION

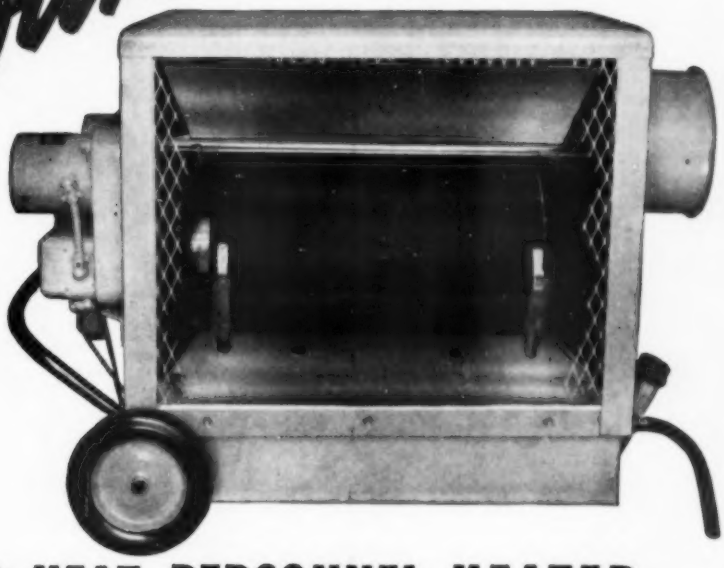
Cameron

IRON WORKS, INC.
HOUSTON, TEXAS



Main Ram — 11,000 Tons
Each Side Ram — 6,000 Tons
Piercing Ram — 3,000 Tons
Total Weight of Press — 3,100,000 lbs.

Announcing...



SILENT GLOW'S

NEW REFLECTED HEAT PERSONNEL HEATER

Here for the first time is a portable heater designed primarily to provide heat for personnel in severe weather when emergency conditions require work to be done outside. Its effective heat is not diverted by wind, rain or snow. Its safe, sure warmth can be supplied at a moment's notice anywhere.

The intense infra-red energy developed by the solar glow flame filter is reflected by stainless steel reflectors which direct these rays (from a very wide angle to a narrow concentrated surface) where they can be most effective. Because of this "directed heat" feature, it is very effective in new construction for drying plaster or paint or for preparing surfaces for such uses. It is also extremely useful for de-icing trucks, buses and locomotive equipment, as the heat can be thrown where it is most needed. It has an air delivery for auxiliary purposes of 1250 cubic feet to be applied at a distant point if desirable. This new heater is a valuable addition to the famous Silent Glow line of portable heating equipment. Get all the facts by sending in the coupon.

Investigate **SILENT GLOW** **PORTABLE HEATERS**

Those Who Know Choose SILENT GLOW OIL BURNERS

THE SILENT GLOW OIL BURNER CORP.
862 WINDSOR STREET • HARTFORD 1, CONN.

Please send me information about the Personnel Heater.

NAME _____

COMPANY _____

STREET AND NUMBER _____

CITY _____ STATE _____

25H53R

It's a double load

Today's semi-military economy makes it necessary for American industry to double up on production—to supply the needs of our armed forces as well as industrial and civilian requirements.

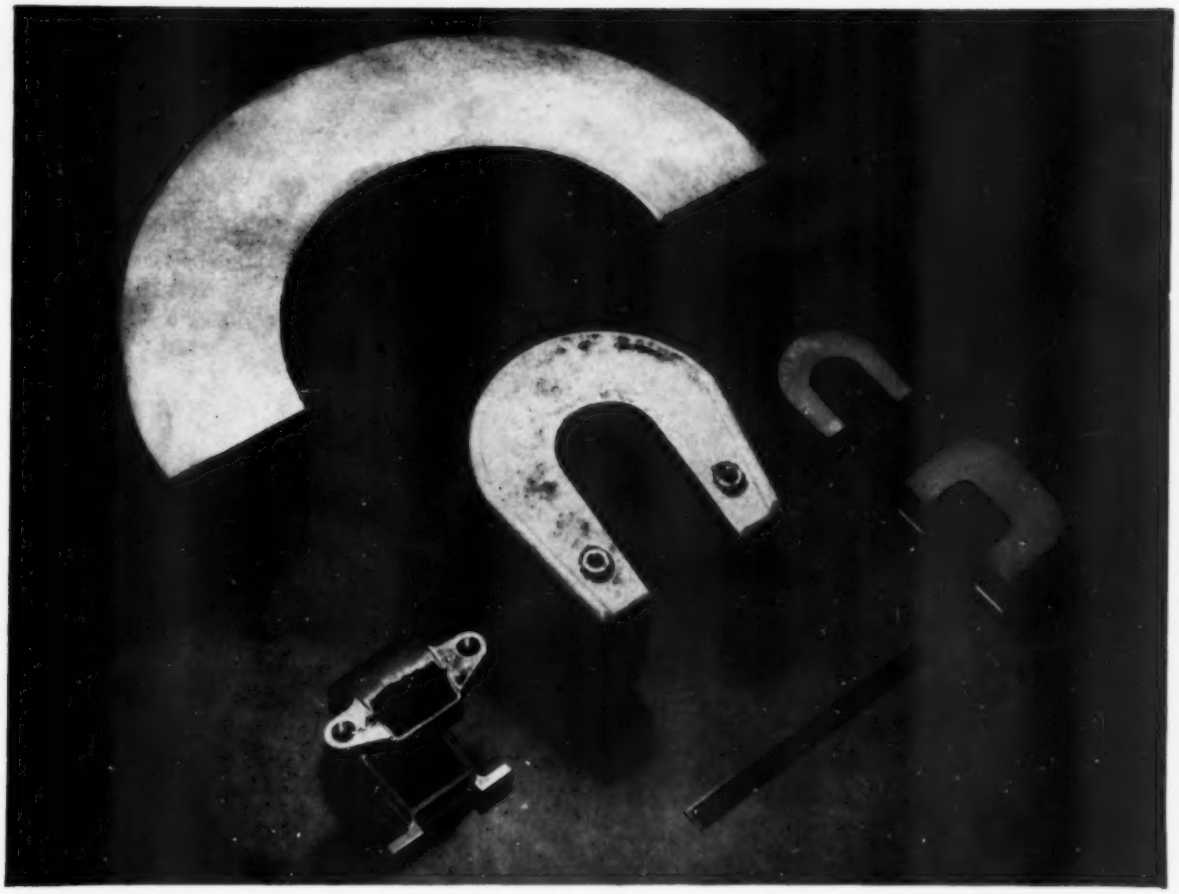
To help further this double-barreled program, American Locomotive has *two separate* production schedules.

For example, one Alco plant is busy turning out modern diesel engines to serve in pumping stations on pipe lines carrying oil for essential military and civilian needs. At another Alco plant, the Army's new medium tanks are being made by Alco's Ordnance Division with the assistance of a network of 2,000 subcontractors.

Other American Locomotive divisions are producing equipment for essential transportation, chemical, petroleum and power industries, with separate facilities devoting their efforts to defense. *Both* lines of production help keep America strong and secure.

AMERICAN LOCOMOTIVE COMPANY

producing both industrial and defense products



PERMANENT MAGNETS and ASSEMBLIES
for Magnetrons and Traveling Wave Tubes

The group of magnets illustrated above, weighing from a fraction of a pound up to 75 pounds, are indicative of the wide range of Arnold production in this field. We can supply these permanent magnets in any size or shape you may need, with die-cast or sand-cast aluminum jackets, Celastic covers, etc. Complete assemblies may be supplied with Permendur, steel or aluminum bases, inserts and keepers as specified . . . magnetized and stabilized as desired. ● *Let Arnold handle your magnetron and traveling wave tube permanent magnet requirements.*

W&D 4598

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

DISTRICT SALES OFFICES

New York: Empire State Bldg. Los Angeles: 3450 Wilshire Blvd.

Made to your Specifications

. . . ANY SIZE, SHAPE OR COATING REQUIRED

★ *We'll welcome your inquiries*

No Problem's Too Tough when you call in ... PRECISION

LARGE CASTINGS

Precision's ability to produce large die castings offers you these specific advantages—

- Makes possible the use of die castings which, if produced by other methods, would cost considerably more.
- By proper design, large die castings can be made stronger and more rigid than the same part produced by other methods.
- Large die castings can be produced combining several smaller parts, thus reducing or eliminating assembly costs.

Since 1909 the name "PRECISION" has been the symbol of highest quality in the die casting industry.

PRECISION CASTINGS CO., Inc.
212 Walnut St., Fayetteville, N. Y.
Syracuse, N. Y. · Cleveland, O. · Chicago, Ill.
Kalamazoo, Mich. · Cortland, N. Y.
British Affiliation — Wolverhampton Die Casting Co., Wolverhampton, England

PUMPS

for ORDNANCE

FLUID POWER PUMPS

Hydraulic power for fire-control; elevating, traversing and loading guns; operation of turrets, steering mechanism and drive wheels of vehicles; materials handling; production and metal forming equipment; raising and lowering ramps, platforms, signal masts, derricks, etc.; powering controls and operational gear on amphibious craft, vehicles and aircraft.

LIQUID HANDLING PUMPS

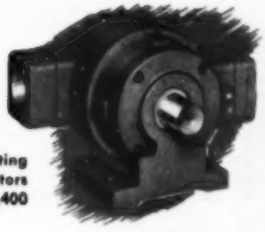
An exceptionally broad range of types, sizes and special constructions to handle virtually "any substance that will flow through a pipe" including: gasoline, acids, sludges, slurries, asphalt, fuel oil and other viscous and non-viscous fluids.

VACUUM PUMPS

High vacuum pumps for laboratory, electronic, atomic research, chemical processing, vacuum refining of metals, dehydration, vacuum drying, refrigeration and de-aerating.

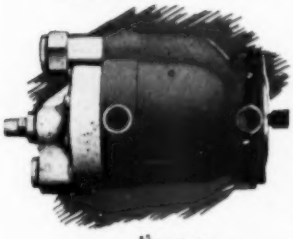
HYDRECO
GEAR TYPE PUMPS

Reversible and non-reversible. Gear type pumps in exclusive FOUR-BOLT design . . . capacities from .5 to 130 gpm and operating pressures to 1500 psi . . . flange or foot mounted . . . furnished with keyed shaft with spline shafts optional. Also dual and tandem models.



DUDCO
DUAL VANE TYPE PUMPS

DUDCO Pumps provide a broad range of sizes with capacities to 120 gpm and pressures to 2000 psi. Also available in dual units operating from a single drive. Hydraulic motors with starting torque outputs to 14,400 lb. in.

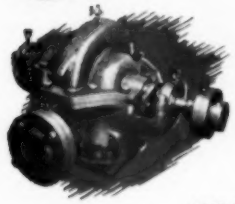


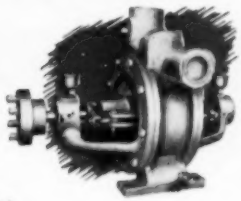
STRATOPOWER
PISTON TYPE PUMPS

Axial reciprocating piston type . . . constant or variable delivery with capacities of .25 to 10 gpm at nominal speeds of 1500 rpm with maximum of 4500 rpm . . . working pressures to 3000 psi . . . direct engine and individual electric motor driven models.

KINNEY
VACUUM PUMPS

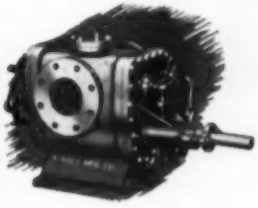
Single stage models to produce absolute pressure readings of 10 microns (.01 mm Hg.) . . . compound pumps producing readings of .2 microns (.0002 mm Hg.) or better. These Kinney High Vacuum Pumps are available in sizes for laboratory as well as high production use.





AURORA
CENTRIFUGAL & TURBINE PUMPS

Deep well, sump, drainage and condensation return units, household water systems. Industrial low and high pressure liquid handling pumps. Direct motor and countershaft driven horizontal and vertical models. Capacities 3 to 7500 gpm.



KINNEY
LIQUID HANDLING PUMPS

A complete range of sizes in Rotating Plunger and Herringbone Gear Pumps to handle light or heavy liquids, from gasoline to asphalts. Available in plain or steam jacketed models.

THE NEW YORK AIR BRAKE COMPANY
230 PARK AVENUE • NEW YORK 17, N. Y.

THE NEW YORK AIR BRAKE COMPANY
230 Park Ave., Dept. O, New York 17, N. Y.
Gentlemen: Kindly send me additional information on:
Hydraulic Pumps ☐ 1000 psi ☐ 2000 psi ☐ 3000 psi Liquid Handling Pumps ☐ Vacuum Pumps ☐

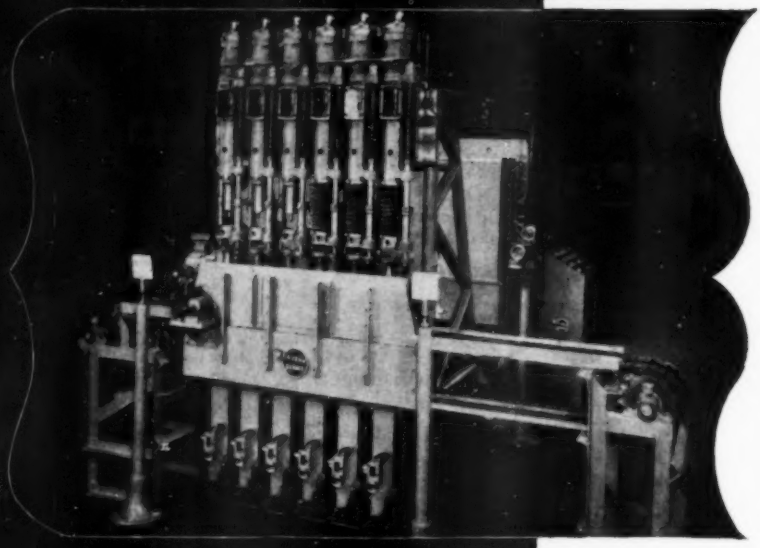
Name.....
Address.....
City.....State.....

Cavity Facing and Shell Banding Equipment By

W. F. & JOHN BARNES

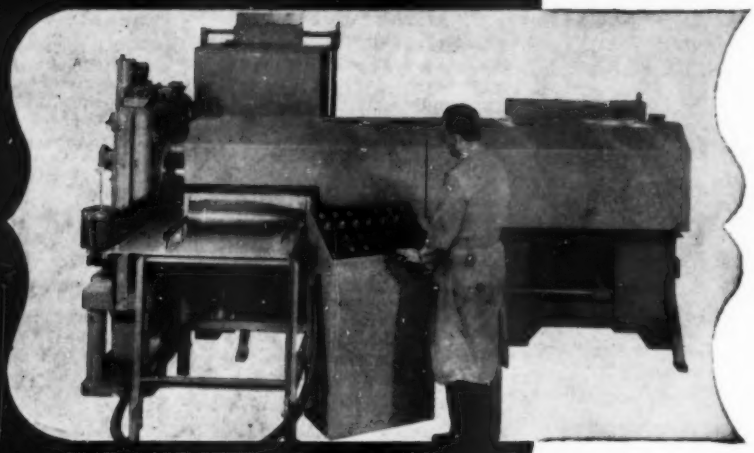
Over 1000 105 MM Explosive Shell Charges Faced Per Hour

Now face or drill cast or consolidated explosive shell charges fast, accurately and with full remote control safety. This Barnes Machine can be furnished to accommodate shells from 57 MM to 8" including 2.36, 3.5, 4.5 rockets and 81 MM and 4.2 mortars. Fully interlocked mechanisms eliminate operators from the hazardous area. Illustrated is a 6-spindle model; 2 and 4 spindle machines are also available.



Band Over 300 105 MM Shells Per Hour

The machine illustrated will receive the shell and the band, transfer them to the multiple jaw banding head, band in a single squeeze motion and eject the banded shell in a completely automatic cycle. A minimum of work hardening of the rotating band is a direct result of this single squeeze banding method. This machine will band either live or inert ammunition. Auxiliary equipment for the banding operations includes machines for band resizing, band deburring, band size checking and debanding. Infeed and take away conveyors, custom designed to suit your plant, can be furnished as a package with the Banding Machine.



Other BARNES Ordnance Equipment

In addition to these machines, the Barnes Company has designed and manufactured machines in the following categories:

a) Zone storage units,
b) Zone weigh handling mechanisms,
c) Fuze tensioning machines,
d) Custom handling devices for all phases of Ordnance work.

Complete electrical, hydraulic and mechanical facilities are available to coordinate these mechanisms into a smooth processing operation.

W. F. & JOHN BARNES

Free Additional Literature

is available on all Barnes Ordnance equipment. Since it is impossible to give the complete scope of operation in this restricted space, we invite you to write for the complete Barnes Ordnance book. Ask for bulletins O-1153.

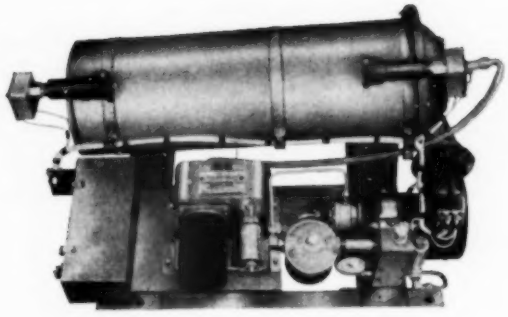
W. F. and JOHN BARNES

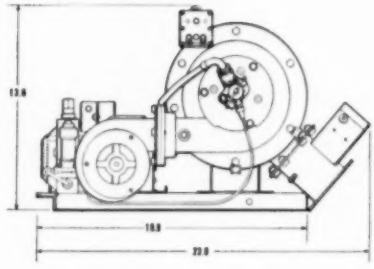
PROGESS EQUIPMENT DIVISION 388 SOUTH WATER STREET, ROCKFORD, ILLINOIS

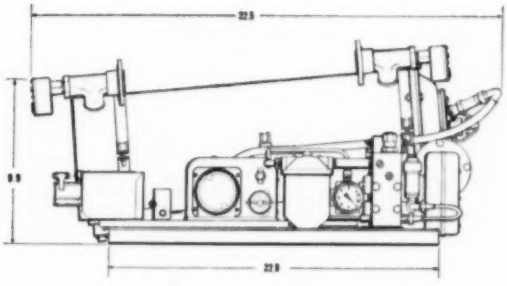
it takes a

JANITROL SIMPLIFIED LIQUID HEATER

to give all of these:







dependability

Thousands of military vehicles have proved that Janitrols *do* the job. "U.R.s" are virtually non-existent—proof of field dependability. "One shot" acceptance on installation qualification tests . . . Janitrol liquid heaters passed every one the first time . . . further proof of Janitrol manufacturing dependability.

adaptability

Design for present or projected vehicles is simplified. Closed system of 1" tubing is easier to install, affords greater flexibility, saves space. Heater uses vehicle fuel—gasoline, diesel or jet fuel. Applications include fuel preheating, cab, cargo and engine pre-heating, defrosting, and maintenance of correct diesel engine operating temperature.

efficiency

Extra heat transfer area, coolant container walls exposed to radiant and convected heat. Sealed in whirling flame combustion chamber plus counter-flow coolant travel result in top heat transfer efficiency.

economy

"Demand" operation (fully automatic cycling) conserves fuel, means longer heater life. 90,000 Btu/hr output, maximum (continuous full capacity operation) fuel consumption less than one gal/hr.

maintenance ease

Interchangeable "plug-in" components speed inspection and servicing. All units, except combustion chamber, accessible for servicing without removing heater.

PLUS SERVICE & SAFETY PROVEN WORLD-WIDE

Janitrol *Liquid* Heater service is proved, not just in a laboratory, but on thousands of military and commercial vehicles *in the field*, all over the world.

Janitrol Liquid Heaters exceed all trade and military specifications for safety! Automatic blower overrun purges heater after each shutdown. Dual contact, fully radio shielded, high tension ignition system is completely hazard free, unaffected by extremes of weather or altitude.

Janitrol's wealth of vehicle heating knowledge, the culmination of over 36 years combustion engineering experience, is at your command through our nearby field representative.

Condensed Specifications

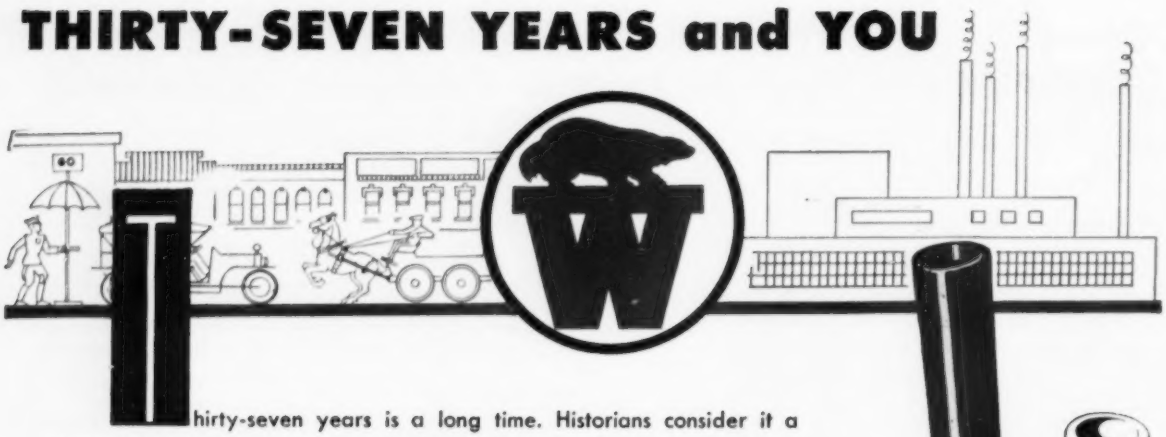
operation	diesel oil, gasoline, or jet fuel
weight	80 lbs
output rating	90,000 Btu/hr
fuel input (continuous operation)	less than 1 gal/hr at rated output
fuel pressure	30–32 psi
power requirement	5–6½ amp at 24 volt dc
stack temperature rise	650 to 750° F
coolant circulation (calculations 30° F rise)	Water–5 gal/min Ethylene Glycol (60/40)–9.6 gal/min

HEAT WHEREVER YOU WANT IT **Janitrol**

AIRCRAFT-AUTOMOTIVE DIVISION SURFACE COMBUSTION CORP., TOLEDO 1, OHIO

National Sales, Engineering, Production Headquarters, 400 Dublin Ave., Columbus 16, Ohio. District Engineering Offices: New York, 225 Broadway; Washington, D. C., 4650 East-West Highway; Kansas City, 2201 Grand Ave.; Ft. Worth, 2509 West Berry St.; Hollywood, Calif., 7046 Hollywood Blvd.; Columbus, Ohio, 400 Dublin Ave. Executive Offices: 2375 Derr St., Toledo 1, Ohio.

THIRTY-SEVEN YEARS and YOU



Thirty-seven years is a long time. Historians consider it a generation. Many things happen in that length of time to change our lives. The passing years add experience that guides our forward steps.

Since the start of our business, thirty-seven years ago, many changes have taken place at Wolverine. Each has been a step forward—the natural result of experience that has been constantly furnishing the inspiration for us to keep looking ahead in search of better ways of doing things, in order that we may bring you the best tube products that human effort, skill, and modern equipment can provide.

Our efforts are not alone confined to the manufacture of tubing, but also to finding ways and means that will make the application of tube most practical—either in the original tube form or as a fabricated tubular part.

As tube specialists, we interest ourselves in both the production of tubing and its ultimate use. We feel it part of our responsibility to see that Wolverine tube functions to its fullest capacity. We know how to build the finest tube that skill and equipment can produce. And we can fabricate it in any shapes your specifications demand from the following metals—copper, copper base alloys, electric-welded steel, and aluminum (2S or 3S).

We are proud to say that Wolverine Tube Division has produced many tubular parts for ordnance, meeting government's rigid specifications for World War I and World War II, including such items as percussion primer bodies and rotating bands. Through this long period of service in meeting government requirements, we accept such orders with a thorough understanding of what is expected; and deliveries will be made accordingly.

WOLVERINE TUBE DIVISION

of CALUMET & HECLA, INC.

Manufacturers of Quality-Controlled Tubing

1467 CENTRAL AVENUE • DETROIT 9, MICHIGAN

ESTABLISHED 1916

Plants in Detroit, Mich. & Decatur, Ala. *Sales offices in Principal Cities*

EXPORT DEPT., 13 E. 40th ST., NEW YORK 16, N. Y.

UNITED

35,000 TON FORGING PRESS

ONE of two new 35,000 ton hydraulic forging presses being built by UNITED for the USAF Heavy Press Expansion Program to help bring the United States to a commanding position in the production of modern aircraft for the armed services.

UNITED

ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

Plants at Pittsburgh • Vandergrift • New Castle • Youngstown • Canton

Subsidiaries: Adamson United Company, Akron, Ohio
Lobdell United Company, Wilmington, Delaware
Stedman Foundry and Machine Company, Inc., Aurora, Indiana

Designers and Builders of Ferrous and Non-Ferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.

FAIRCHILD POWER for the RYAN FIREBEE

JET POWER to send a remote-controlled, high-altitude missile streaking across the sky at near-sonic speeds called for a new concept in powerplant design.

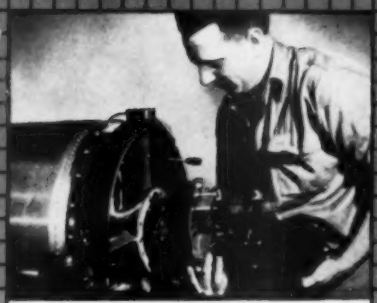
Fairchild met the challenge with the J-44 turbojet engine. It had to be extremely compact—yet provide more thrust than any engine of its size ever developed. It had to be expendable for warfare—yet quality-built for frequent re-use in research and training after parachute recovery.

In one application recently revealed, Fairchild's J-44 provides the power for the Firebee, a target drone with fighter plane performance, made by the Ryan Aeronautical Company.

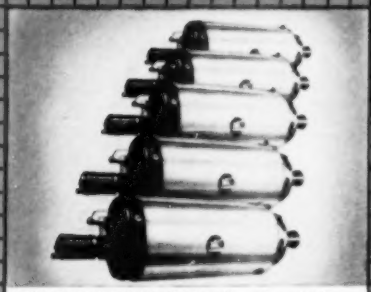
TIME WILL TELL of the expanding role in the nation's guided missiles program, in light aircraft and as a supplementary powerplant in large aircraft of this engine concept that *had to be different* . . . another example of the design, development and production facilities of Fairchild fulfilling specialized power requirements.

J-44 SPECIFICATIONS

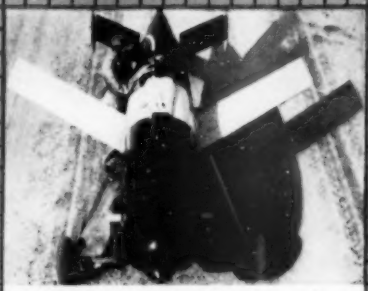
Announced thrust	*1000 lbs*
Weight	*300 lbs*
Length	*72 inches*
Diameter	*22 inches*



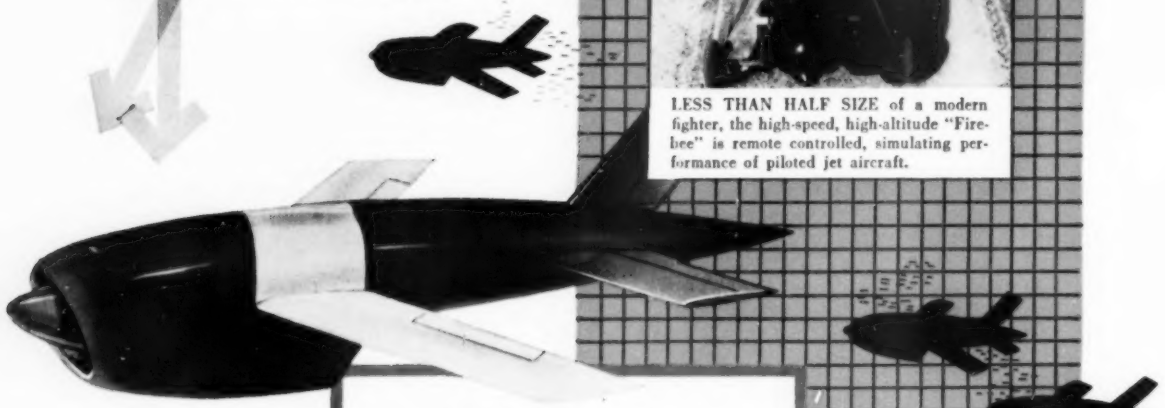
ACCESSORY SECTION containing essential controls, is quickly removed and replaced without special tools.



ONLY 72 INCHES LONG and weighing 300 pounds, the J-44 has varied applications in the nation's guided missiles program as well as in piloted aircraft.



LESS THAN HALF SIZE of a modern fighter, the high-speed, high-altitude "Firebee" is remote controlled, simulating performance of piloted jet aircraft.



ENGINE AND AIRPLANE CORPORATION

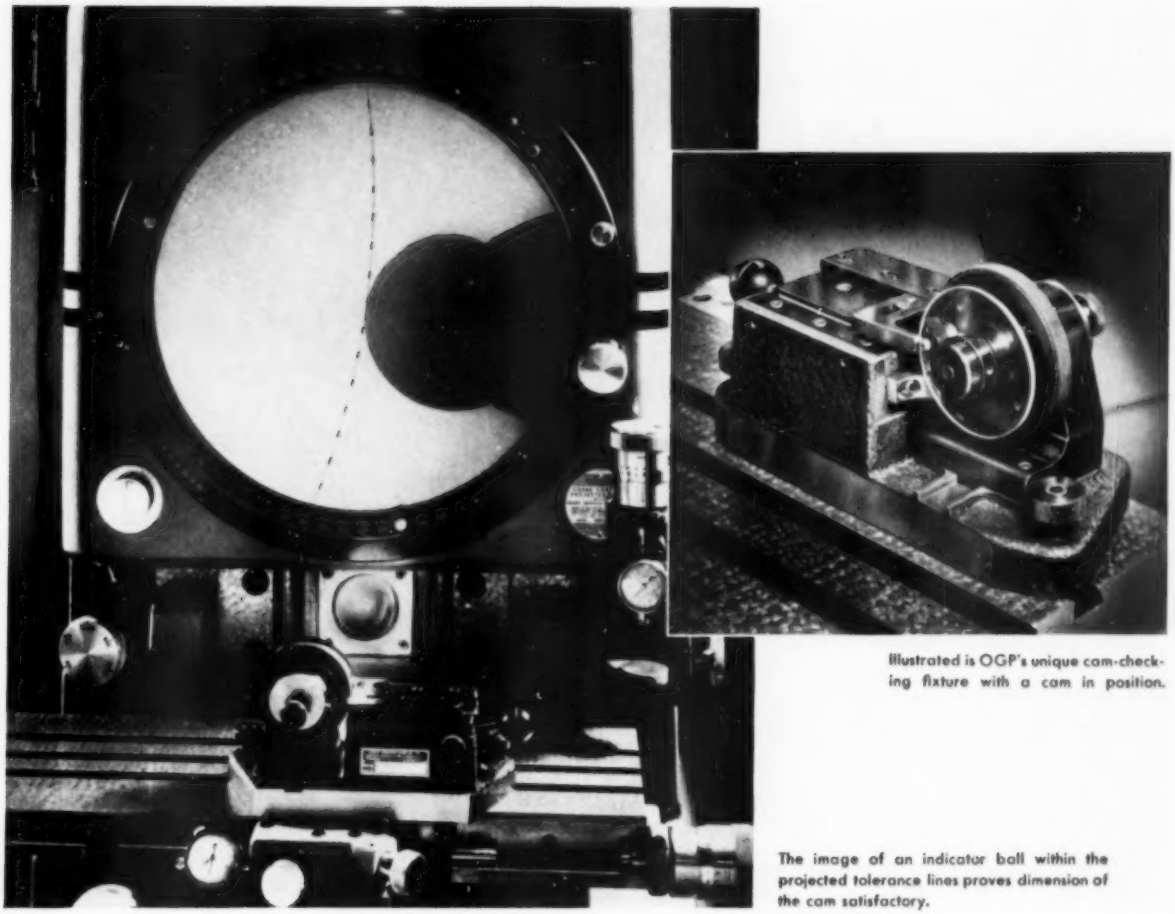
FAIRCHILD

Engine Division

Farmingdale, L.I., N.Y.

Aircraft Division, Hagerstown, Md.

Guided Missiles Division, Wyandanch, L.I., N.Y.



Illustrated is OGP's unique cam-checking fixture with a cam in position.

The image of an indicator ball within the projected tolerance lines proves dimension of the cam satisfactory.

How cam inspection time was reduced from **13 hours to 40 seconds**

The inspection of irregular cam contours is difficult at best.

That is, it was until Optical Gaging Products, Inc., developed a unique method for General Electric Company. This optical gaging technique inspects irregular cams by optical gaging in 40 seconds instead of the 13 hours previously required by mechanical techniques.

Using a special reticle fixture, the operator simply turns a knob that rotates the cam and makes sure an indicator ball appearing on the screen of the optical comparator stays within the tolerance lines. Tolerances as close as .0005″ may be readily inspected.

This is typical of the way in which optical gaging is solving all sorts of complex and time-consuming inspection problems, quickly and accurately. Our engineering staff is available to help you solve your problem. Just write us, sending sample parts and specifications, and we'll make a suggestion. Or, if you wish, our field representative in your area will call.

OPTICAL GAGING PRODUCTS INC.

SUCCESSORS TO ENGINEERS SPECIALTIES DIVISION OF UNIVERSAL ENGRAVING AND COLORPLATE CO., INC.

26 FORBES STREET, ROCHESTER 11, N.Y.

SPECIALISTS IN PROJECTION GAGING

What it takes to train a bombardier!

15,130 Gallons' Gas — 100 Bombs for Bombing Runs — 265 Hours' Flight Training — 1,814 Hours' Ground School

This tremendous investment in time and materials is necessary to turn an airman into a skilled bombardier! But costly as it seems, it's a bargain compared to what it would be without radar training devices that ground-train aircraft observers. These devices simulate actual flight conditions and enable Air Force personnel to learn to hit the target... before they ever leave the ground!

These new electronic trainers not only do a better job of training much more quickly, but effect tremendous savings in fuel, personnel, airplane maintenance, practice ammunition and bombs.

The Electronics Division of American Machine & Foundry Company, working closely with the Air Force through its various Commands, derives great satisfaction from the part it plays in keeping our Air Force the best-trained in the world.

AMERICAN MACHINE & FOUNDRY COMPANY

Executive Offices, 511 Fifth Avenue, New York, 17, N.Y.

AMF does it better—automatically!

CREATORS AND PRODUCERS OF ELECTRONIC AND MECHANICAL EQUIPMENT FOR THE ARMED SERVICES : Radar antennae and drive units • automatic loaders for Army and Navy weapons • elevating and azimuth mechanisms • cooling fans for Army tanks • airplane parts • mobile ovens • electronic training devices • naval ordnance • rolled and welded steel products • shell components • silver-zinc batteries • special military projects

■ A recent Associated Press dispatch (date-lined Western Front, Korea, July 14) featured the vital role played by the new M75 Armored Personnel Carrier. In part, that story reads, "The army revealed Monday how it evacuated United States seventh division soldiers safely in daylight along a dirt road winding south from abandoned Pork Chop hill under heavy Communist shelling . . . the full-tracked vehicles, sheathed and roofed with tough armor plate, brought back the wounded and other soldiers—and some of the dead—left on Pork Chop in the last hours of the gallant United States stand . . . mortar and artillery shells, machine gun and rifle bullets pounded the carriers in this first trial under fire. Only one was damaged seriously . . . the seventh division announced no casualties in the operation."

International Harvester has had long experience in manufacturing machines for transportation, industry and agriculture, some of it extending back for more than a century. It is a combination of that experience, mass-production facilities and forward-looking engineering, that enables IH to produce the M75 Personnel Carrier and other military components in line with the specialized requirements and rigid specifications of the Armed Forces.

INTERNATIONAL HARVESTER Chicago 1, Illinois

Builders of products that pay for themselves in use . . .
International Trucks • McCormick Farm Equipment and Farmall Tractors
Crawler Tractors and Power Units • Refrigerators and Freezers

In designing and fabricating parts, components and products for the Aviation Industry, we must often employ extraordinarily complex procedures . . . But the prime element in all of those procedures can be stated in one very simple word—"PRECISION!"

THE STEEL PRODUCTS ENGINEERING CO.

Precision in Aviation since 1914

SPRINGFIELD, OHIO

Everybody *but the kitten has a front-row seat*

About the only vantage point from which you won't view television in perfect comfort is on top of, or in back of, your receiver. Provided, of course, that it's *"Panoramic Vision"* you're watching.

Television manufacture, the past few years, has been so involved in the battle of the tubes, knobs and gadgets that some engineers have forgotten the basic objective—to provide the best possible viewing comfort and clarity *to the greatest number of people.*

Stromberg-Carlson—which, incidentally, makes TV receivers which excel in any feature—studied this common problem of the range of viewing.

And here is the simple, but superbly satisfying answer we found. Instead of recessing the picture tube some distance behind the traditional "safety glass," we employ a cylindrical tube *snug against* a curved safety glass. That's all there's to it—but the result is to provide a crystal-clear, undistorted picture for at least twice as many viewers.

This exclusive feature is called *"Panoramic Vision"* and it's an example of the imaginative engineering which has distinguished all products of this company for more than half a century.

There is nothing finer than a

Stromberg-Carlson® Rochester 3, New York

STROMBERG-CARLSON ALSO LEADS IN . . .

Telephones and Central Office XY Dial Equipment

High Fidelity Radios and Radio-Phonographs

Office Intercom Equipment

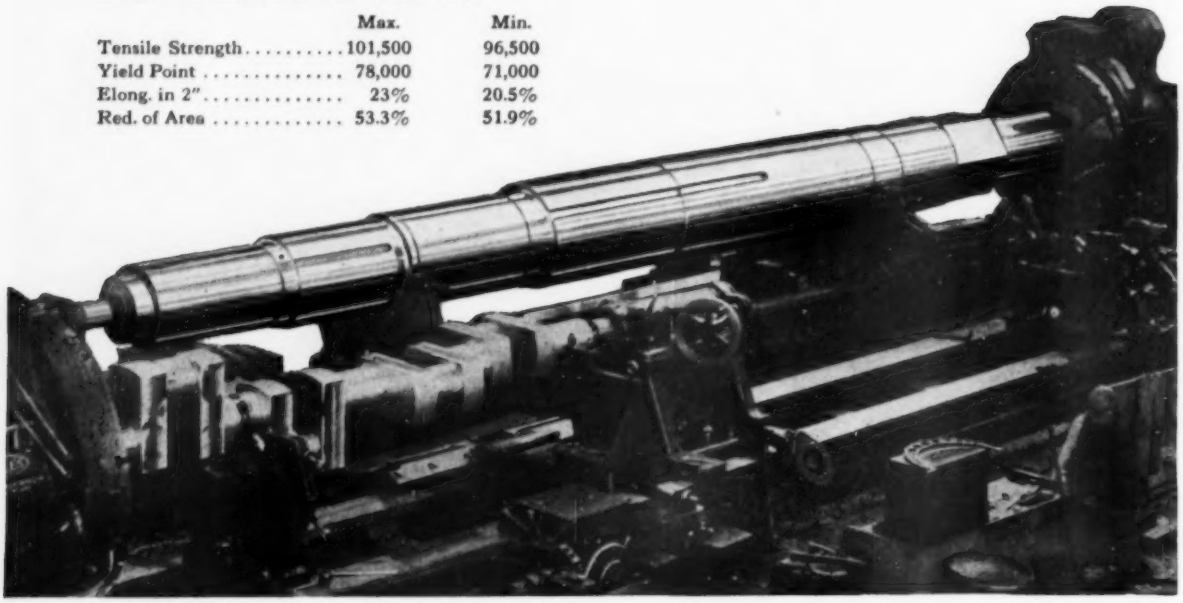
Electronic Carillons for Churches and Public Buildings

Sound and Public Address Systems

In Canada: Stromberg-Carlson Co., Ltd., Toronto

NICKEL STEEL FORGING . . . a 58,950 lb. hoist drum shaft, 24" in diameter at its widest portion and 42' 9" long, produced by ERIE FORGE & STEEL CORP. Inspection revealed very fine grain. After being normalized and drawn, actual tensile tests in the longitudinal direction showed the following:

	Max.	Min.
Tensile Strength	101,500	96,500
Yield Point	78,000	71,000
Elong. in 2"	23%	20.5%
Red. of Area	53.3%	51.9%



How Erie Forge Obtains Superior Properties in Large Forgings

To develop high tensile and elastic properties in large forgings, such as this giant shaft, by heat treatment is much more difficult than with smaller forgings.

For even though dimensions of a large piece may allow liquid quenching, section sizes involved ordinarily limit the cooling rates.

Experience shows that superior mechanical properties in large forgings depend largely on suitable alloy content . . .

Fundamentally, that is why the output of ERIE FORGE & STEEL CORPORATION of Erie, Pennsylvania, includes scores of large forgings produced from nickel alloyed steel.

Nickel, either alone or in combination with other alloying elements, exerts highly beneficial influences. Its strengthening effect on ferrite is independent of carbon content or heat treatment of the steel, while its effectiveness in reducing the rate and temperature of the upper transformation, induces better response to the necessarily milder heat treatments used.

Nickel alloy steels may help you obtain peak performance from vital parts of *your* products or equipment. Send us the details of your problems for our suggestions. Write us now.

At the present time, nickel is available for end uses in defense and defense supporting industries. The remainder of the supply is available for some civilian applications and governmental stockpiling.

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

Remington Rand Methods News

Simplified, visible production control for maintaining schedules

What's the status of any (or all) jobs in your plant? What assemblies, parts, machines or manpower will you need to maintain schedule. What are the delivery dates? These *facts*, with complete supporting data can be available *instantly* in one simplified, visible record—SCHED-U-GRAPH.

SCHED-U-GRAPH completely centralizes *all* the necessary information for effective production control. There's no digging in statistical reports, tub files, registers or card files. No hurried phone calls. Everything you need is conveniently charted, up-to-date and instantly accessible. SCHED-U-GRAPH so simplifies production control that any supervisor, or even a clerk, can answer *any* question about *any* job at *any* time.

Can SCHED-U-GRAPH help keep *your* production on schedule? We believe it can. And to prove our point, and to give you further information about this flexible, convenient control, we have prepared a case history folder which explains how Tinker AF Base *simplified* production control with SCHED-U-GRAPH. This four-page certified report explains how this huge Air Force Depot uses SCHED-U-GRAPH boards to maintain full control over such diverse operations as: An aircraft assembly line three-quarters of a mile long, a series of shops for repairing and manufacturing parts and accessories, and a network of administrative offices.

Let us send you this complete report. You'll quickly see how SCHED-U-GRAPH can offer *your* business, no matter how large or complex, the same convenient charting of job statuses, item by item, with integrated full supporting data in one easy, accessible record. Ask for **Certified Report #795.**

Portion of SCHED-U-GRAPH installation at Tinker AF Base. Each board is 48 inches high by 44 inches wide and carries 100 visible file pockets. Fiber Guide Wheels permit the board to be raised or lowered for reading or posting.

Tabulating machines prove a boon for medium-sized plants

You don't have to be a giant of industry to realize important savings through the use of punched-card tabulating equipment.

One west-coast tool manufacturer, with 675 employees, centered all its machine hours, labor, sales analysis, payroll and special reports in *one* 5-clerk department, thanks to the efficiencies of punched-card procedures.

What were the savings? In sales analyses alone punched cards gave them a report that previously took 37 days, *in the amazingly short time of 3 days!* Payroll preparation, production control, labor distribution, efficient inventory, even income tax returns for employees were handled with similar efficiencies in time and expense. In the words of their chief accountant: . . . "it would have been difficult to operate with anything like our present efficiency, without these economical and *complete* production sales and general accounting controls." See **Certified Report 804.**

15 or more carbon copies at one typing

"One great advantage of the electric machine is the number of clear carbons that can be obtained, particularly for government contracts" writes the President of a Boston manufacturing company. Let us show you how the Electric typewriter brings you dividends of sharp, clean carbons, as well as increased production and distinctive printwork. Write for Case History **RE 8536** and "Take a Letter" **RE 8499.**

How to solve troublesome "peak load" invoicing problems

A manufacturer of electronic equipment writes us: "Since we have been using the Printing Calculator for extension and computing taxes, invoicing has kept pace with shipments, *even during peak periods.*" Read the complete history and learn how this all-purpose machine combines short-cut multiplication, automatic division, high-speed addition and subtraction in one unit. Ask for **folder AC 633.**

Remington Rand

Operators of the Louisiana Ordnance Plant

Management Controls Reference Library

Room 1404, 315 Fourth Ave., New York 10, New York

Please circle the literature you desire

CR #795 AC 633 CR 804

RE 8536 Folder RE 8499

Name_____

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Firm_____

Address_____

City_____ State_____

L 13

— Profit-Building *IDEAS* For Business —

Allis-Chalmers Industrial Capacity

PROVIDES TOOLS OF SECURITY

An Allis-Chalmers HD-5G Tractor Shovel is secured in the cargo hold of a flying boxcar, ready to parachute to earth from 1,500 ft. altitude.

M8E-2 Cargo Carrier has the power, speed and traction to handle tough, off-road assignments such as towing big guns . . . moving personnel and supplies.

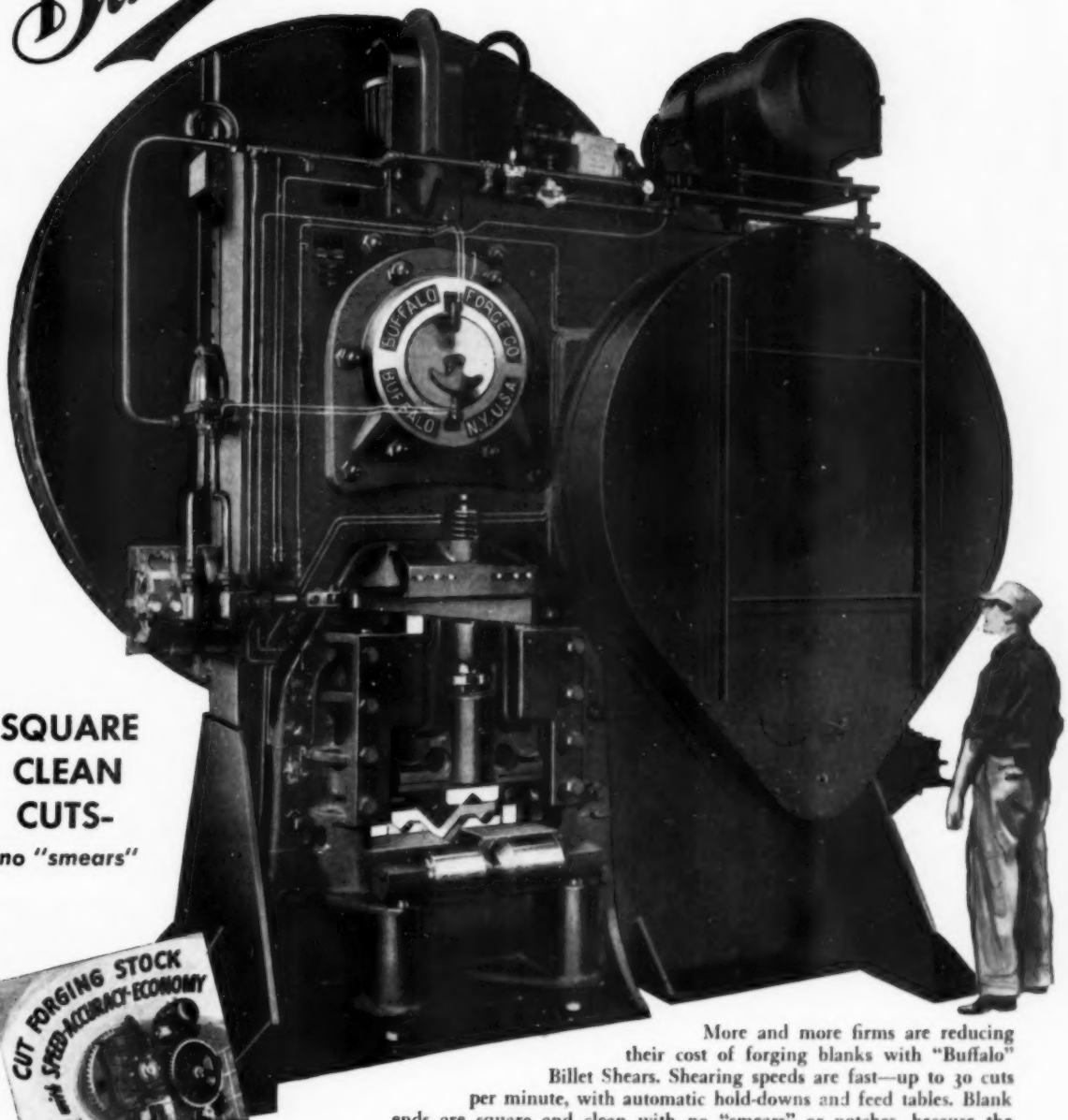
Soon after landing, the HD-5G is available for such jobs as helping in the construction of air strips, clearing land and building camp sites in remote areas.

The "Bull Moose" is a massive, rubber-tired, 300-hp. tractor for bulldozing, operating scrapers or handling other heavy drawbar work at high speeds.

ALLIS·CHALMERS

PRODUCER OF THE WORLD'S LARGEST LINE OF MAJOR INDUSTRIAL EQUIPMENT

"Buffalo" FOR HIGH-PRODUCTION BILLET SHEARING



SQUARE CLEAN CUTS-
no "smears"

More and more firms are reducing their cost of forging blanks with "Buffalo" Billet Shears. Shearing speeds are fast—up to 30 cuts per minute, with automatic hold-downs and feed tables. Blank ends are square and clean with no "smears" or notches, because the knives penetrate only 3/16", localizing a sharp vertical fracture. Porosity is easily detected. For better forging practice, start with a "Buffalo" Billet Shear. Sizes up to 10" rounds and 9" squares. Write for Bulletin 3295.

"Buffalo" MACHINE TOOLS

BUFFALO FORGE COMPANY

534 BROADWAY BUFFALO, NEW YORK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

DRILLING PUNCHING SHEARING CUTTING BENDING

One-Stop shopping

for brass rod and bar

You can get rod or drawn bar of Chase Free-Cutting Brass, Copper or a wide variety of other copper alloys at one stop – *the Chase Warehouse nearest you!*

When you want free-cutting materials, it pays to buy Chase – for Chase rod and drawn bar yield the shorter chips that make for *easier machining, longer tool life.* They produce smooth, clean-surfaced products – less expensive to buff or polish before lacquering, enameling or plating.

And when it comes to re-ordering, remember that Chase alloys are uniform – repeat orders of the same alloy always have the same cutting characteristics.

Chase BRASS & COPPER

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass & Copper

Albany†	Cleveland	Kansas City, Mo.	New York	San Francisco
Atlanta	Dallas	Los Angeles	Philadelphia	Seattle
Baltimore	Denver†	Milwaukee	Pittsburgh	Waterbury
Boston	Detroit	Minneapolis	Providence	
Chicago	Houston	Newark	Rochester†	(†sales
Cincinnati	Indianapolis	New Orleans	St. Louis	office only)

PRODUCING
America's Toughest Electro-Mechanical Jobs!

GM
GENERAL MOTORS
GM
GOOD MANAGEMENT

AC
KNOW HOW

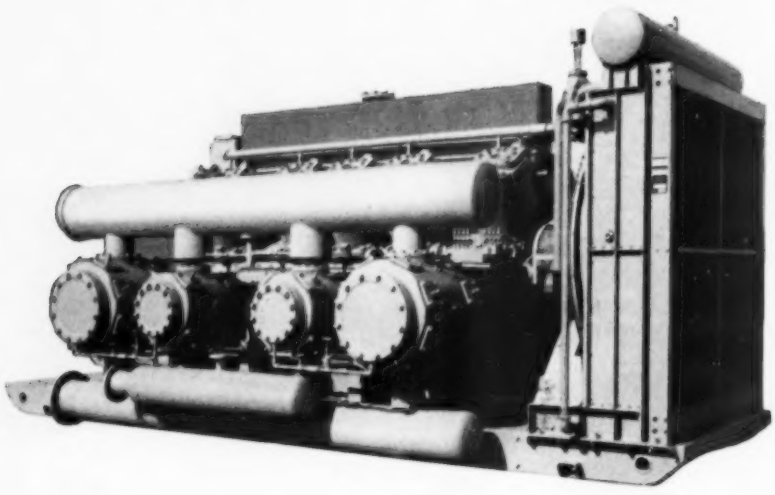
DEFENSE PRODUCTS
of High Quality at Low Cost
DELIVERED ON TIME

For dependable electro-mechanical devices—on or ahead of schedule—at assembly-line savings—the record proves you can always count on AC!

- **EXPERIENCE**—we are currently producing such highly complex assemblies as "A" Series Gun-Bomb-Rocket Sights—A-1A Bombing Navigational Computers—T-38 Skysweeper Fire Control Systems.
- **KNOW-HOW**—700 top-drawer engineers, scientists and technicians.
- **SKILLED LABOR**—thousands of highly trained production specialists.
- **CAPACITY**—3,000,000 square feet of floor space in three great plants.
- **FACILITIES**—35,000 modern machine tools all geared for action.
- **SOURCES**—1,468 seasoned sub-contractors and suppliers working closely with us.

AC SPARK PLUG DIVISION • GENERAL MOTORS CORPORATION • FLINT, MICHIGAN

Another Example of Beaird Manufacturing Skill



PACKAGED AIR COMPRESSOR

Developed specifically for use in ordnance shell manufacturing, the Beaird packaged air compressor uses the same basic design as the widely used Beaird packaged gas compressor plants. This packaged compressor, installed singly or in multi-unit banks provides compressed air for shot blast and sand blast machines, paint spraying equipment and all pneumatic tools and controls. It is fully assembled at the Beaird factory to lower assembly costs and save installation time.

THIRTY-FIVE YEARS EXPERIENCE in manufacturing a wide variety of products has made Beaird unusually well equipped to handle large production orders of ordnance materials.

Central location near Southwest ports *Experienced engineering staff* *Ample supply of Skilled labor*
Trained inspection department *Modern manufacturing facilities*

SINCE 1918
BEAIRD
SHREVEPORT
MACHINING FABRICATING STEEL WAREHOUSE

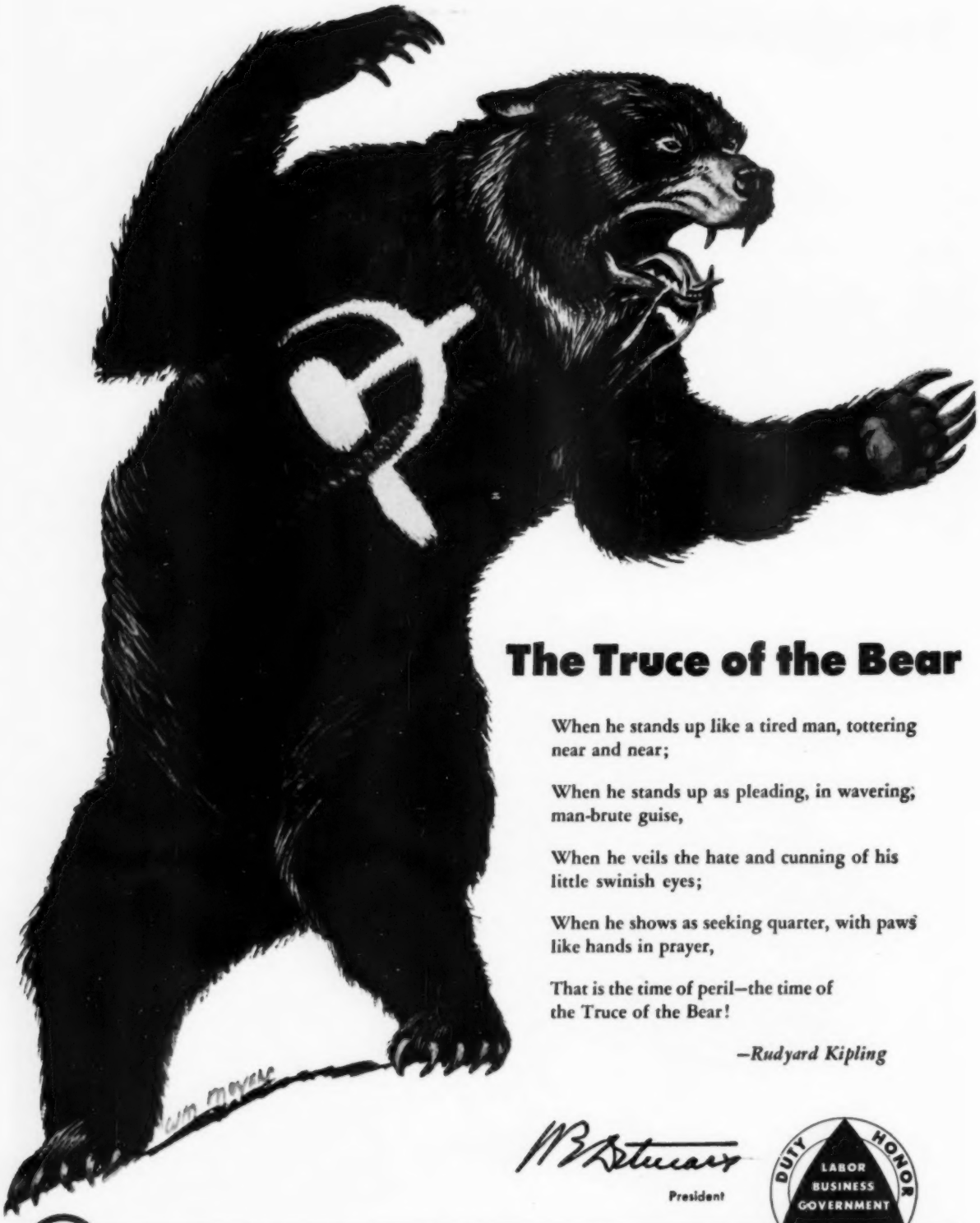
THE J. B. BEAIRD COMPANY, INC. Shreveport, Louisiana

PACKAGED COMPRESSOR PLANTS | LP GAS SYSTEMS | CAST STEEL FITTINGS | ANHYDROUS AMMONIA EQUIPMENT | PRESSURE BULK STORAGE

I once crossed the Alps
with Hannibal.
Now I'm only
a circus animal.
My diet is hay,
whereas REOs (they say)
gobble miles like
a ravenous cannibal.

Definitely... an
EAGER BEAVER

REO MOTORS, INC., LANSING 20, MICHIGAN



The Truce of the Bear

When he stands up like a tired man, tottering
near and near;

When he stands up as pleading, in wavering,
man-brute guise,

When he veils the hate and cunning of his
little swinish eyes;

When he shows as seeking quarter, with paws
like hands in prayer,

That is the time of peril—the time of
the Truce of the Bear!

—Rudyard Kipling

W B Stuart

President

DUTY HONOR COUNTRY
LABOR BUSINESS GOVERNMENT

The Gray Manufacturing Company, Hartford 1, Connecticut

Makers of Audograph and PhonAudograph Electronic Soundwriters

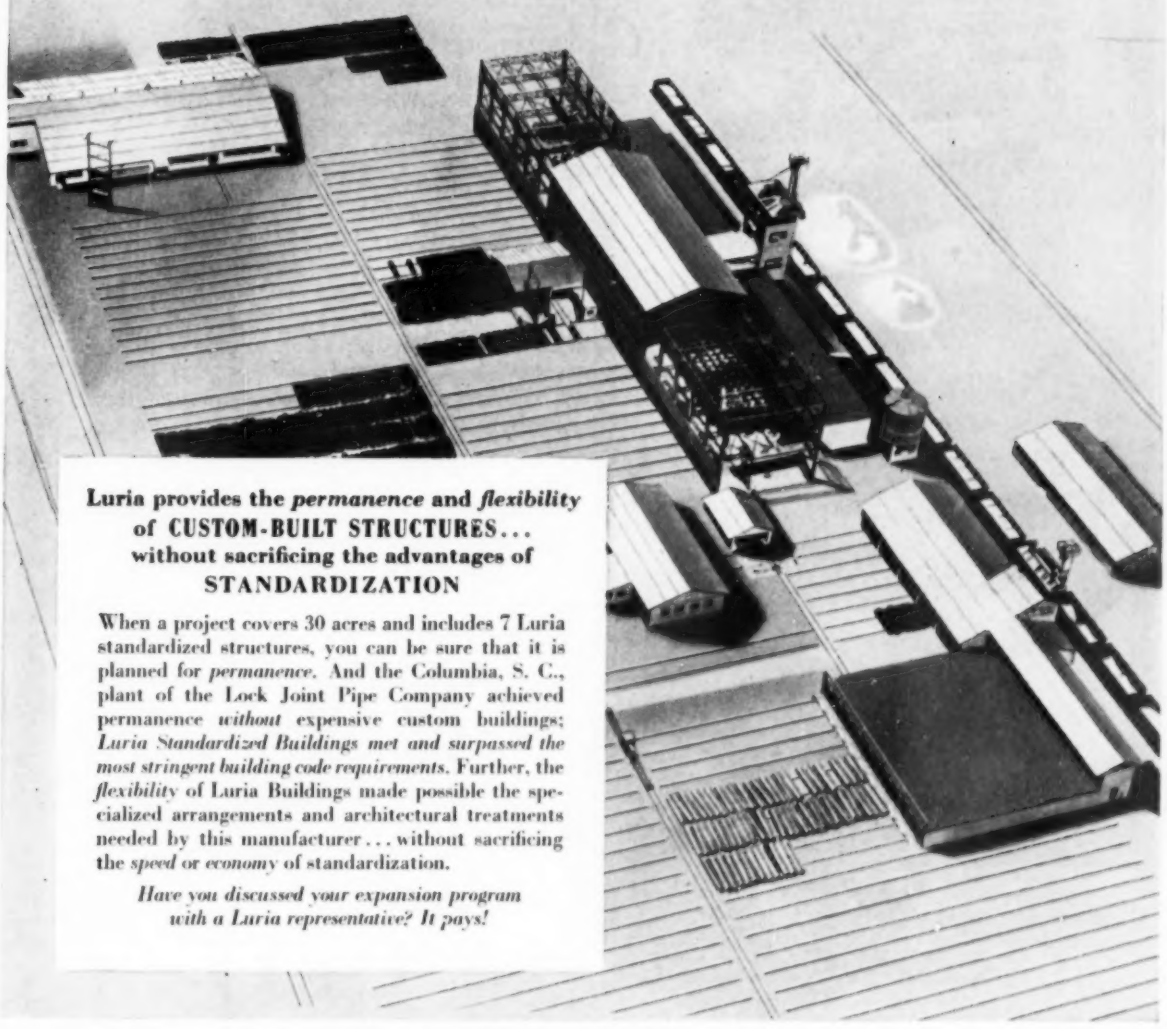
AND GRAY RESEARCH AND DEVELOPMENT CO., INC., Specialists in Video, Audio, Sub-Audio Electronic Mechanisms

Another Industrial Leader...

LOCK JOINT Pipe Company

chooses

LURIA Standardized Buildings



Luria provides the *permanence* and *flexibility* of CUSTOM-BUILT STRUCTURES... without sacrificing the advantages of STANDARDIZATION

When a project covers 30 acres and includes 7 Luria standardized structures, you can be sure that it is planned for *permanence*. And the Columbia, S. C., plant of the Lock Joint Pipe Company achieved permanence *without* expensive custom buildings; *Luria Standardized Buildings met and surpassed the most stringent building code requirements.* Further, the *flexibility* of Luria Buildings made possible the specialized arrangements and architectural treatments needed by this manufacturer... without sacrificing the *speed* or *economy* of standardization.

Have you discussed your expansion program with a Luria representative? It pays!

LURIA ENGINEERING COMPANY

500 FIFTH AVENUE, NEW YORK 36, N. Y.

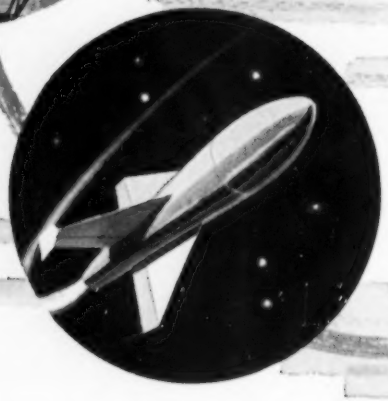
District Offices: ATLANTA • PHILADELPHIA • BOSTON • CHICAGO • WASHINGTON, D. C.

Formula for leadership in the GUIDED MISSILE FIELD

$O + F + E$

ORGANIZATION—Today North American Aviation's guided missile program is manned by more than 4800 highly skilled and imaginative scientists, engineers and craftsmen . . . many of them leaders in their particular fields . . . integrated into one of America's foremost organizations in guided missile development.

FACILITIES—Often invented to fit a specific need . . . North American's great array of technical equipment used in guided missile projects staggers the imagination. A great part of this equipment at North American's testing grounds and research facilities at Santa Susana and Downey, California is completely new and unique in American industry.



EXPERIENCE—North American began pioneering research in the guided missile field before V-J Day. The knowledge provided by North American's advanced work in miniaturization, rocket engines, rockets, ballistics, fuels, automatic navigation and flight mechanisms . . . and in actual test firings . . . is helping to speed America's progress in all phases of guided missile and rocket development.

NORTH AMERICAN AVIATION, INC.

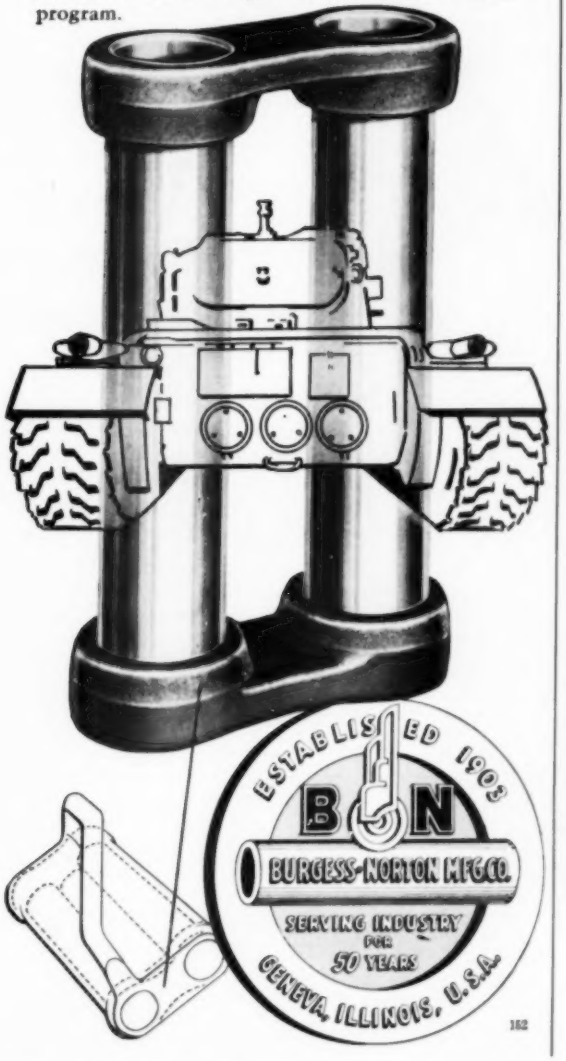
TWENTY-FIVE YEARS OF BEING AHEAD OF UP-TO-DATE

A HALF CENTURY

SERVING INDUSTRY AND THE ARMED FORCES

Burgess-Norton played an important part during World War II, in the development and production of tank track parts.

Since that time our development engineers have been constantly redesigning these track parts to keep pace with the many improvements and design changes in America's tanks. Today Burgess-Norton experience, skill and facilities are again producing new, improved tank track link bodies, to meet the requirements of the tank track program.



182

zero to

70,000 cycles per second

...recorded on one tape recorder, the Ampex Model 311

This versatile Ampex recorder is a combination of a wide-range direct recorder for high frequency phenomena and an fm-carrier recorder for highly transient or extremely low frequency phenomena requiring excellent amplitude accuracy. It provides a means for recording nearly every type of data encountered in laboratories and in industry.

The Ampex 311 uses two parallel channels on quarter-inch tape. The direct recording channel handles frequencies from 300 to 70,000 cycles per second. The fm-carrier channel has high transient accuracy in the range from 0 to 5,000 cps.

The Ampex 311 can record diverse types of data signals with a common time base. For instance, the fm channel might record high transient phenomena or low frequency signals while the direct channel records wide-band multiplexed signals or other high frequency information. Either channel can record a time signal.

AMPEX Model 311 Combination Recorder

Two parallel channels cover a wide range of data situations:

The fm channel

- Frequency response, 0 to 5,000 cps, ± 1 db.
- Transient accuracy independent of minor tape flaws and irregularities.

The direct channel

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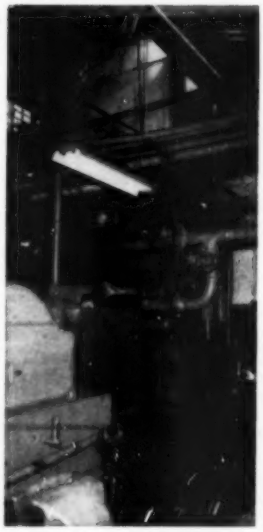

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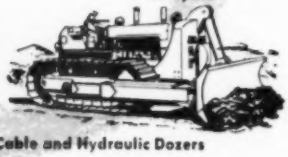

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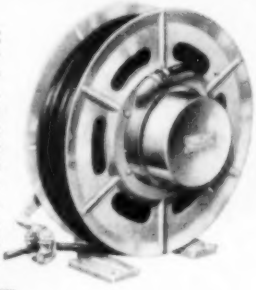

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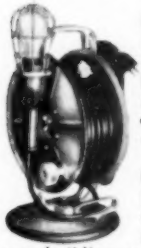

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GOVERNMENT FINISH SPECIFICATIONS

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SPECIFICATION	PARKER PRODUCTS
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Grade I	Bonderite 100, 160, 170, 180
Grade II	
Type 2	Parco Cleaners 341, 350, 371
Type 4	Parco Cleaners 250, 260
Type 5	Parco Cleaners 210, 220
Type 6	Parco Cleaners 100, 101, 110
MIL-10578 (Formerly U.S.A. 3-213)	
Type I (Wash-off)	Parco Cleaner 250
Type II (Wipe-off)	Parco Cleaner 260
MIL-C-5541 (Formerly AN-C-170)	Bonderite 710 (chemical film for aluminum and its alloys)
MIL-C-16232 (BuORD)	
Type I	Parco Lubrite 1 & 2
Type II	Parco Compound
PA-PD-191	
Grade I	Bonderite 32, 34, 100, 160, 170, 180
Grade II	
Type 2	Parco Cleaners 341, 350, 371
Type 4	Parco Cleaners 250, 260
Type 5	Parco Cleaners 210, 220
Type 6	Parco Cleaners 100, 101, 110
U.S.A. 72-53	Bonderite 32, 34, 100, 160, 170, 180
U.S.A. 57-0-2	
Type II	
Class A & A1	Parco Lubrite 1 & 2
Class B	Parco Powder—Parco Compound
Class C	Bonderite 100, 160, 170, 180

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Type I Medium	NC-710
Type I Firm	NC-711
MIL-T-6841	(DK-153 (RK-304S
Type II Soft	DC-167
Type II Medium	DC-100
Type II Firm	DC-113
MIL-G-6747	DK-149

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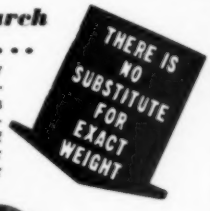
A New Laboratory & Research SHADOWGRAPH Scale . . .



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INDEX TO ORDNANCE

VOLUME XXXVII

● The Index to Volume XXXVII of ORDNANCE, with title page for binding, is still available. It will be sent free of charge upon request to the Editorial Offices at the address below.

● It covers subjects in the following 1952 and 1953 issues: July-August (No. 193); September-October (No. 194); November-December (No. 195); January-February (No. 196); March-April (No. 197); and May-June (No. 198). It is arranged alphabetically by subject and author.

AMERICAN ORDNANCE ASSOCIATION
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MM MODERN MACHINERY

INDUSTRIAL ENGINES

MODERATE SPEED
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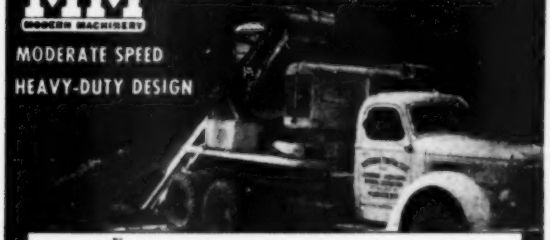

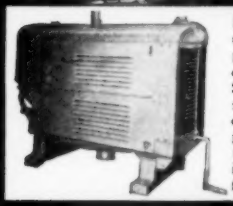

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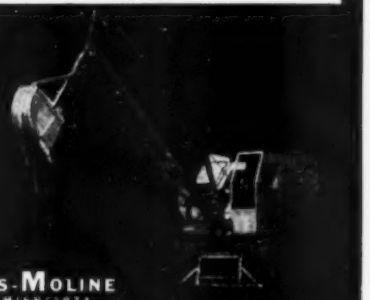

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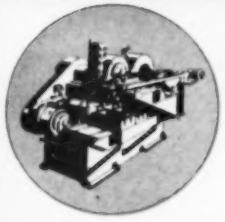

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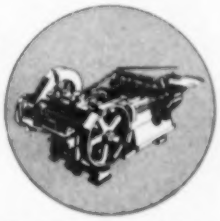

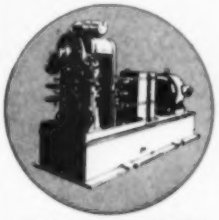

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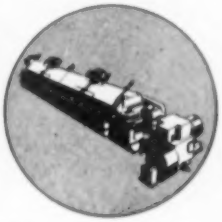

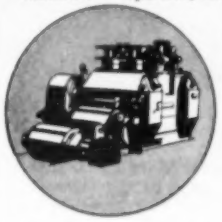

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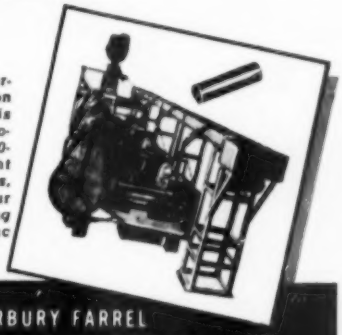

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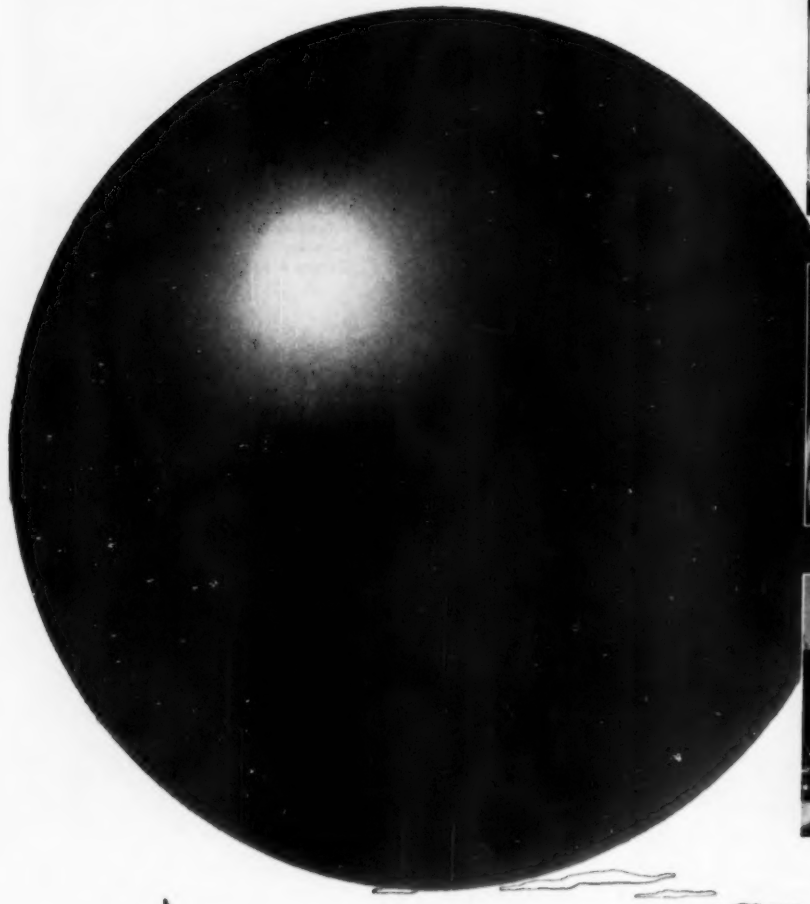

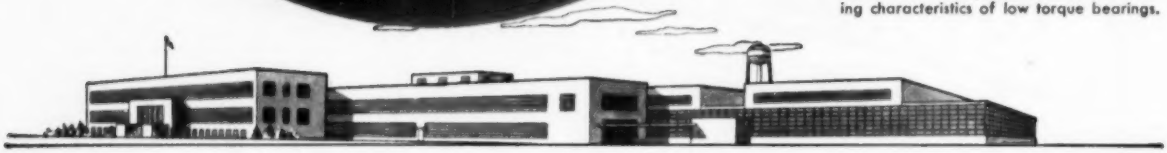

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ARMAMENT TECHNOLOGY

This section of ORDNANCE contains articles of a detailed and technical nature on ordnance research, development, manufacture, field use, and related subjects.

Training Aids

Ordnance Can Contribute Much to Their Development

Capt. C. C. Martin, Ord. Res.

General Supervisor, Missiles Service, Douglas Aircraft Company, Santa Monica, Calif.

IT has always been difficult to reach agreements on just how much money should be spent on training aids in support of a major item of Ordnance equipment. Probably too much money has been spent when funds were readily available and not enough when they were scarce. Furthermore, there is no uniformity of thought on the matter of how funds should be distributed among various types of training aids.

Suggestions Offered

Because of this it is important that any training-aid program be scrutinized carefully at its inception to assure that maximum value is obtained for money spent. This article offers some suggestions for program development and organization based upon the experience of the Douglas Aircraft Company in numerous training-aid programs for aircraft and missiles.

First of all it is important to determine that a need for training aids actually exists. The development in the past of many elaborate pin-ball-type machines, impressive to the casual observer but relatively useless to an instructor, has done much to discredit training aids.

However, military equipment is becoming increasingly complex and expensive; if one training aid can be responsible for preventing one man from destroying one large item of complex equipment it will often pay for the cost of the entire training-aid program.

On the other hand, in most cases simple graphical material can convey basic principles as well as or better than a complicated demonstrator. The problem is to find the correct balance between simplicity and effectiveness.

The experience of the Douglas Aircraft Company has shown that the Ordnance Training Command can make a large contribution to the development of any training aids supporting Ordnance matériel. Personnel of the command have developed a number of techniques of graphic presentation that are highly effective despite their moderate cost. In addition they are well qualified to interpret the training policies and requirements of the appropriate Army school.

Example of Teamwork

In short, the relationship between the Ordnance Training Command and contractors can be an excellent example of Ordnance-industry teamwork and coöperation.

Since it may be agreed that training aids should be developed for many programs and that the Ordnance Training Command can make a large contribution to their development, the next question is "who should develop the training aids?"

Modern thinking in the procurement of complex weapons stresses the "weapons system" approach, whereby one contractor with perhaps a large subcontractor is given the responsibility for development and production of all equipment needed for a weapon. Ordnance has used this philosophy with

CONTENTS

Training Aids 517
Capt. C. C. Martin
The Mighty Mite 520
M/Sgt. Roy G. Carbine, U.S.M.C.
Ultrasonics in Liquids 524
K. R. Newnham
Rust Prevention Today 526
Joseph Szanto
Amphibious Giant 529
Harry A. Jacobs
Biggest Forging 532
A pictorial account
Packaging Ordnance 533
Robert Dickey, III

marked success in several major programs.

Following this concept, it is logical that the contractors developing and producing a "weapons system" should be responsible for developing the supporting training aids. Under such an arrangement, planning for training aids can start as soon as a production order is received.

Economies Possible

Cognizant contractor personnel will have followed the equipment during its development phase and can continue to introduce production design changes into the training aids. Economies can be effected since parts and know-how are more readily available, and the cost of educating a separate training-aids designer on the weapons system is avoided. Finally, contractual and administrative procedures suitable for carrying out the development are usually already established. Thus the items become available sooner at a lower cost.

In the case of certain specialized trainers, it may be desirable for the major contractors to subcontract the development, but the prime contractor should still have responsibility and control of the effort in order to assure integration of the trainer into the entire training-aid program.

It may be of interest to review the organizational arrangement used by the Douglas Aircraft Company to handle training-aids development. The Service Department is responsible for handling customer relations concerned with the use of delivered equipment.

In addition to its functions of field-service assistance, technical liaison, and the training of customer personnel on new equipment, it also has the responsibility for coördinating training-aid programs.

However, no major design or art group is maintained for the sole purpose of developing training aids. Service Department personnel, because of their association with the customer in training-aids programs and other activities relating to the introduction of new equipment, are in close touch with the customer's training problems and requirements.

Field-service instructors can contribute suggestions based on needs appearing in their preparation of training programs. Also technical liaison activities of service personnel can keep them informed of the design capabilities of other departments in the company, such as engineering and publication groups that have made a large contribution to all past programs and have carried out a great deal of development work on training aids.

Rivalries Prevented

Under such an arrangement there is no group dedicated to developing more and larger training aids, nor is there any group interested in pushing its pet product as a training aid to the relative exclusion of all other types. Instead the company objective is to attain the most effective program at the lowest cost.

Before turning to a discussion of specific training aids it would be well to point out that no training aid is worth while unless it is used often and properly. The contractor service organization can contribute considerably by following up on the use of training aids in the field and making suggestions for their more effective use.

Newest Device

Among various types of training aids, the overhead projection transparency is the newest and the most flexible. In this method a transparency is projected onto a screen in much the same manner as a 35-mm. slide. However there are some significant differences.

First, the size of the transparency, approximately eight inches square, permits the instructor to write on it during projection with a special erasable wax crayon or to point with a pencil whose image is projected on the screen.

Secondly, a series of overlays can be prepared and projected sequentially or simultaneously on the screen. This permits the development of a complex mechanism or electronic circuit, section by section, followed by a presentation of the entire subject matter. In addition, each overlay can be made in a different color, lending clarity, vividness, and interest to the presentation.

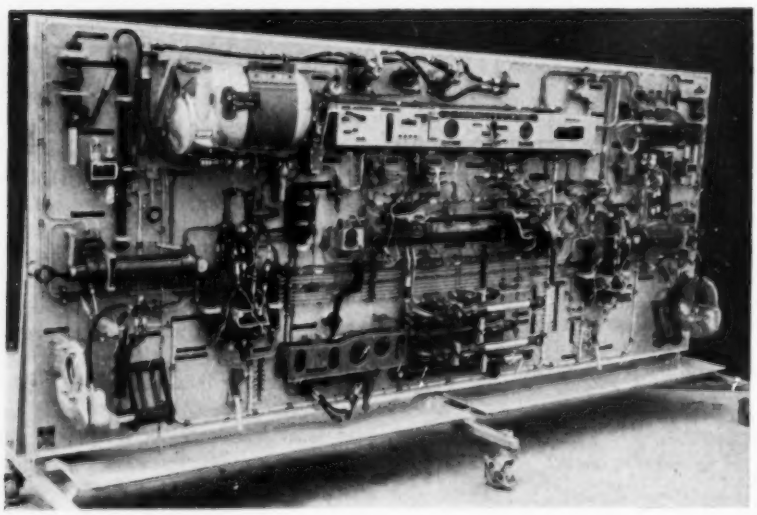
The primary cost in making these transparencies is that of drafting the overlays; production costs with photography, Ozalid, or similar methods are nominal. Incidentally, this feature makes them ideal for color reproduction by military units which have only ordinary printing facilities available.

Limitations

The chief limitation of OPT's, as they are sometimes called, is the difficulty of portraying very complex subject matter which requires the use of intricate color presentation. Also they are not as suitable as are wall charts when a training situation requires that a specific piece of graphic information be displayed during an entire lecture.

Wall charts, previously the mainstay of graphic training aids, are better than ever today despite inroads made by overhead projection transparencies.

This maintenance trainer shows the operating controls of an AD-4 hydraulic system.



Some subjects simply cannot be described adequately without wall charts. Complicated mechanisms, extensive hydraulic or pneumatic systems, and other complex subjects require the versatility of the colored wall chart.

Innovations in presentation introduced by Ordnance Training Command personnel include the use of a black background for better visibility, elimination of numerous unessential details, and the use of a bold schematic style where possible.

In summation, it may be mentioned that the principal advantage of wall charts is their independence of special projectors, classroom facilities, etc. Indeed, an instructor with good wall charts can give good instruction under almost any conditions.

Slides Favored

Slides for classroom projection have long been favorite training aids. Actually any art work prepared for either charts or overhead projection transparencies can be converted to slides with minimum cost.

Art work developed properly for these also can often be used as a basis for technical-manual illustrations, a procedure that resulted in considerable savings in one recent program at the Douglas Aircraft Company.

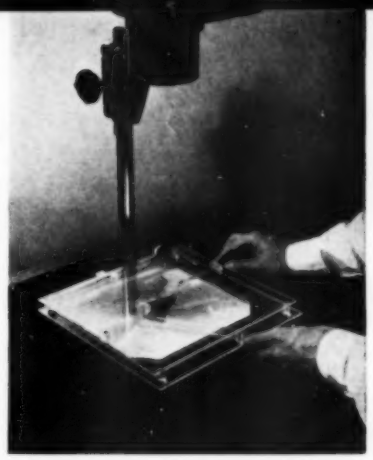
It should be noted here that the Douglas Publication Department has played a considerable part in developing some of the graphic techniques described in this article.

In concluding general remarks about graphic training aids it is safe to say that most training needs can be met by graphics of one kind or another; the few exceptions are noted below.

Operable Transparencies

A particularly novel version of overhead projection transparencies is the operable type. These operable OPT's are constructed of colored transparent pieces of plastic assembled so as to permit movement which is projected onto a screen.

Although very intriguing results can be obtained with such devices, their use should be limited because of their high cost compared with static transparencies. In a few cases, however, they are worth while; *e.g.,* mechanical linkages and portrayals of operating panels containing a large number of switches and lights that can be turned on or off.



Above, operable overhead projection transparency of C-118A landing gear downlatch mechanism. Corner detail orients the mechanism within the actual aircraft.

Above, static overhead projection transparency of C-118A landing gear hydraulic system with overlays showing oil routing in "gear-up" and "gear-down" functions.

In the first case, good visibility and realism are obtained without complex machinery. In the second case, the device is useful because actual panels are too small for large classroom visibility; static presentation does not permit showing the relation among various switches, lights, and indicators, and large-size models of panels are too expensive.

Models of equipment have been used considerably in the past. Their application also is limited but highly effective in showing linkages and internal mechanical construction. They have the advantage over operable overhead projection transparencies in that students can actually operate the models, which adds to both the interest and the learning process.

Finally, the most elaborate type of training aid is the complex mechanical device known variously as a demonstrator-trainer, or simulator. Considerable care must be exercised to avoid wasting money on these devices; sometimes even a plan agreed upon enthusiastically by every one concerned may turn out to be a dud when it reaches the classroom.

Actual Equipment Best

Actual equipment rather than a complex simulator is usually best and cheapest for training. However, simulators for pilot and maintenance training have demonstrated their worth. Trainers are useful when the actual equipment is so closely packaged or components of a system are so widely spread out that the student cannot get a good picture of the component system in the tactical equipment.

In order to achieve a program with a proper balance between the training aids noted above and an adequately early completion date, the following procedure is suggested.

Contractor personnel responsible for training-aid development should meet with the Ordnance Training Command representatives to determine requirements; then the contractor should make a study to determine what training aids should be developed.

This is best accomplished by trying to do the entire job with the least expensive type of training aid available; any gaps in the required coverage then can be determined. An effort should be made to fill these gaps with the next most economical method. Following this procedure sequentially will tend to minimize the cost of the entire program.

Final Authorization

After the analysis of training-aid requirements is presented in a report to be studied by appropriate Army agencies, final authorization to proceed can be incorporated in contractual arrangements that, ideally, were started at the time of the production release.

Continued liaison between the Ordnance Training Command and the contractor, coupled with vigorous support of the program by the latter, can result in that rare phenomenon—effective training aids available before or simultaneously with the issue of new equipment to the using arm.

The Mighty Mite

The new lightweight truck has such a low center of gravity that it will slide off the side of a hill before it will overturn. (Marine Corps photos.)

Marine Corps develops powerful utility vehicle light enough for rapid transport by helicopter

by

M/Sgt. Roy G. Carbine, U.S.M.C.

THE Marine Corps believes it may have solved a major transportation problem. Faced with the necessity of obtaining a powerful lightweight utility vehicle of 1,500 pounds or less for rapid transportation by helicopter, the Marine Corps Equipment Board at Quantico, Va., has come up with the record-shattering "Mighty Mite."

Use of the helicopter in Korea established the principle of rapid movement of troops by air to inaccessible points without benefit of landing strips.

Cargo Drops Limited

Units thus transported could be supported and maintained indefinitely by the 'copters. But cargo and ammunition drops were limited to the weight of the load a man could carry.

Therefore, it was necessary to produce a highly mobile and maneuverable vehicle that would meet the helicopter's maximum lift load of 1,500 pounds.

At the same time the vehicle had to be capable of towing or transporting infantry loads including such functions as: (1) ammunition and general cargo resupply, (2) casualty evacuation, (3) such general message-center use as wire laying, (4) prime mover for infantry weapons capable of being lifted by helicopter, (5) reconnaissance for any units landed by helicopter, and (6) a mobile gun platform for firing the 105-mm. recoilless rifle.

The Truck, Utility, ¼-ton, 4x4, Lightweight, otherwise known as the "Mighty Mite," is the answer.

Problems Solved

According to Maj. Harold L. Palmer, U. S. Marine Corps, who directed the public unveiling tests of the dynamic new vehicle at Quantico, two major problems have "largely been solved" by development of the Mighty Mite. The problems, of course, are the old spectres of resupply of isolated units in rough terrain and the vital mobility of helicopter-borne assault forces.

"Tactical possibilities of helicopter assaults," Major Palmer observes, "have been broadened for the Marine Corps by obtaining the versatile 'Mighty Mite.'

"The very apparent need," he adds, "for a prime mover light enough to be carried by 'copter and for use with troops thus transported, has largely been solved."

Exhaustive tests have proved this bantam of only 1,496 pounds to be loaded with power. From a standing start, Mighty Mite has sailed up steep slopes that stalled a competing vehicle and slogged through a quagmire that bogged down the other.

Is Amphibious

In addition to proving its land-air practicability, the 8-foot Mighty Mite took to deep water with its special flotation kit and navigated the Potomac River at Quantico under its own power.

Measuring only 96 inches in length, the Mighty Mite is 58 inches wide and 58 inches high. The vertical height may be further lowered to 45 inches by lowering windshield and steering wheel.

Wheel base of the new vehicle is only 64½ inches, with a 50-inch tread. The wheels are of the 15-4.50 safety-hump type, and use 5.90-15, 4-ply tires. Really a ground-hugger, the Mighty Mite has a ground clearance of 9¼ inches.

Sergeant Carbine, a Marine combat correspondent and a veteran of thirteen years' service with the Corps, is presently assigned to Marine Corps Headquarters, Washington, D. C.

Although nearly 1,200 pounds (1,496 pounds against 2,665) lighter than the jeep, work horse of World War II, the Mighty Mite has a pay load of 1,000 pounds. On rough terrain it can carry a pay load of 500 pounds while towing another 1,000 pounds.

Mobile Weapons Carrier

Landed from a 'copter with a simulated assault force at Quantico, the versatile little slogger accomplished unprecedented moving and towing feats.

Employed as a base for a 4.2-inch mortar weighing 333 pounds, the Mighty Mite provided a highly mobile weapons carrier for mortar, 5-man crew, and ammunition. Vehicle, weapon, crew, and ammunition may be placed on the landing site by two helicopters.

As an ambulance, the Mighty Mite was used to "evacuate" two litter cases and two attending medical corpsmen. The vehicle may be used for the rapid evacuation of seriously wounded in terrain that formerly permitted only the use of litterbearers on foot.

Mounting a 105-mm. recoilless rifle weighing nearly 700 pounds, the Mighty Mite was exhibited as a highly mobile gun platform from which the weapon could be fired and displaced to any alternate firing position in a minimum of time.

Because of the smoke, flash, and dust involved, one of the most serious problems in the employment of the 3.5-inch multiple rocket launcher is counter-battery fire from the enemy.

Firing a salvo, the launcher and its 4-man crew were immediately moved by the Mighty Mite to a new and distant firing position during the Quantico demonstration. Crew, launcher, ammunition, and vehicle comprised a 3-helicopter load.

Utilization Unlimited

During the Korean fighting, helicopters themselves have been used to increase the rapid mobility of multiple rocket launchers. In the dual use of the "whirly-birds" and the Mighty Mite equipped with this weapon, effective utilization of the launcher is almost unlimited.

In another demonstration, the Mighty Mite was used to establish ammunition supply and resupply from helicopter landing point to front-line units or gun emplacements, towing ¼-ton cargo trailers. Trailer and 900 pounds of ammunition comprise a short pay load for one 'copter.

Placed on a landing site as a prime mover for preloaded trailers, the Mighty Mite may also be loaded with additional supplies prior to taking the trailer in tow.

Establishing speedy wire communication between units comprised another part of the successful demonstrations. In this exhibition, four rolls of WD-1TT wire and wire reel unit RL-31 were used. Two helicopters and a complete wire-laying crew of two men together with vehicle and equipment were placed on the landing site.

The Mighty Mite was also used to provide vehicular radio equipment and an operator for a theoretical tactical air control party.

Air-cooled Engine

With a top speed of 50 miles an hour, the lightweight truck is powered by an air-cooled Porsche engine driving through a 3-forward-, 1-reverse-speed transmission and 2-range transfer case which gives the vehicle 6 forward and 2 reverse speeds. The 4-cylinder (opposed) engine is 79 cubic inches in size, has overhead valves, and develops 44 brake horsepower at 4,000 revolutions a minute.

Its triple-duty tubular frame serves the Mighty Mite as muffler and exhaust pipe to give a quieter and more economical operation than any accessory muffler made.

No Back Pressure

There's no roar from the Mighty Mite's air-cooled engine and no back pressure to rob power from the four horizontally opposed cylinders, according to H. A. Blenkle, chief engineer at Mid-America Research Corporation, Wheatland, Pa., which developed the radically new military vehicle.

Welded together as a sealed unit, its tubular frame accomplishes much of its silencing action by cooling the exhaust gases so that they shrink to one tenth their volume on leaving the engine. Only a gentle stream of warm gas flows from the exhaust opening at the rear, and in no place does the frame get too hot to touch, even after a long, hard run.

Several times as effective as a standard muffler, using the frame for this purpose aids in two all-important eco-

Above, independent suspension in each wheel enables the Mighty Mite to maneuver perfectly on three wheels. Below, upheld by inflated tubes, the vehicle becomes amphibious, propelled and steered through the water by its own wheels.

nomies—economy of weight and economy of cost.

Weight economy makes the Mighty Mite light enough to be carried by helicopter. Economy of cost tailors its price several hundred dollars per vehicle lower than the cost of its nearest counterpart.

Economy Important

From the Marine Corps' point of view, economy is an important factor in adoption of the vehicle. When accepted for general use, the demand for the Mighty Mite will, of course, govern the supply. With modern technological advancement as evidenced by Mid-America, the unit cost price undoubtedly will be lowered, effecting an economy in military expenditure.

The Marine Corps Equipment board initially ordered one prototype of the Mighty Mite. Tests on this one proved so successful that ten more were ordered. Several of these are presently undergoing continued tests by the Marines, while others are being similiarly tested at the Aberdeen Proving Ground, Fort Knox, Ky., and Fort Eustis, Va.

Biggest innovation in mechanical performance of the Mighty Mite is that each of the vehicle's four wheels has independent suspension. Positive power in all four wheels is assured at all times by locking devices employed in the transfer case and front and rear differentials.

Full power is transmitted to any one wheel that may have traction. During the demonstration tests at Quantico last March, the Mite attained a speed of thirty miles an hour over rough terrain while operating on three wheels.

Seat Patented

In addition to a suspension system that is the envy of Europe's leading sports car designers, a patented seat and a patented steering mechanism make the Mighty Mite the most comfortable and safest rough-terrain vehicle ever devised.

With each wheel independently suspended, there is a full eight inches of vertical wheel travel before the Mighty Mite "hits bottom" on its springs. This is twice the "wheel give" in the ordinary passenger car and provides the Mighty Mite with double bump absorption.

With brakes and differential in the chassis, the Mighty Mite pares unsprung weight to the minimum to provide the best possible smoothness and road stability. Its wheels hug the ground, giving the driver absolute control over the most difficult roads or in open country.

"Floating motion" is both the name and the description of the seat which contributes much to the Mighty Mite's comfort.

When the car hits a severe bump, the bottom and the back of the seat give as a unit, smoothly and gently. Its patented construction has the effect of built-in shock absorbers to slow down its action and prevent a rebound effect. The driver rides in comfort, and stays in his seat over the roughest going. The floating-motion seat has made such a profound impression on the people who have tested it that it is already being adapted to other military vehicles.

Another patented feature of the Mighty Mite is pivot center steering, which completely eliminates the need of "fighting" the steering wheel when going over rough terrain. As on a bicycle, the pivot is directly in line with the wheel, though inside the hub instead of above. As with a bicycle, there is no twisting tendency when a wheel hits a bump.

With pivot center steering the Mighty Mite can be steered easily with the finger tips over the roughest road, or even across country. With the vehicle's amazingly smooth ride and comfortable seat, this eliminates the problem of driver fatigue from rough terrain.

Test Driving Eased

Marine test drivers at Quantico report that they can stand eight hours of test driving in the Mighty Mite but have to call it quits after two hours in conventional vehicles in which they must constantly fight the steering wheel to maintain the proper control.

The Mighty Mite has been driven at 50 miles an hour into a 6-inch curb, and there was no rending thud or crunch—just a reassuring "bloop" from the tires. Because the suspension allows the wheels an 8-inch vertical travel on the springs, the shock is all absorbed by the tires and springs.

Since the upward thrust of both the front and back wheels as they hit a bump is near the center of the frame, there is no bucking. The truck remains level.

Mighty Mite's road stability impressed military and press observers during the Quantico tests. The squat vehicle, because of its low center of gravity, will slide off a steep incline rather than overturn. It can traverse al-

The Mighty Mite negotiates an 80 per cent grade during recent performance tests.

most any terrain that a tank can master.

With all its vital parts in sight and in arm's reach when the hood is raised, the Mighty Mite takes the Braille system out of motor maintenance. Every component of the engine is at the mechanic's finger tips.

There are numerous other maintenance short cuts. With its air-cooled engine, there is no bother with coolants or antifreeze; no checking for leaks, no flushing. There's no need to lubricate the permanent nylon bearings in the tie-rod joints. Many other units, such as the eight universal joints, are permanently lubricated.

Engineers at Mid-America are even working on a unified lubrication system for engine, transmission, and differential.

Readily accessible under the stubby hood are the gas filler, oil filler, dip stick, battery, distributor, oil filter, gas filter, fuel pump, generator, and spark plugs—all in easy reach with no obstructions in the way. Slipping out clip-on plates by the front fenders gives access to the overhead valves of the horizontally opposed cylinders.

Taking to the water in tests, Mighty Mite proved its adaptability to Marine Corps land, sea, and air standards. The special flotation kit carried by the Mite allows it to cross unfordable streams and navigate inland waterways. The kit consists of four lightweight rubber tubes and a frame which is attached to the body of the vehicle.

Inflated by the exhaust in a 5-minute operation, these tubes are 17 inches in diameter and 100 inches in length. Front and end tubes each measure 17 by 66 inches.

Tubes Adjustable

Held in place by "jacks," the tubes are adjutable in height. In a low position when the vehicle is afloat, they may be raised to clear ground obstacles when the Mite "wades" ashore.

Although the present flotation kit weighs a bulky 86 pounds, plans call for a substitution of nylon for the rubber now used in the inflatable tubes which will decrease the weight to 65 pounds.

Other than the special kit, the Mighty Mite has no other marine equipment. In the water it is propelled and steered by its own wheels and tires. Maximum speed on water is 2½ miles an hour.

Attachments Discarded

Water-borne tests are of course not concluded. Continued efforts will be made, according to Major Palmer, to increase the Mighty Mite's speed while afloat. While wheel attachments initially planned as propellants were discarded in favor of deeply serrated tires, Mid-America is continuing experiments to increase the vehicle's "seagoing" speed.

The new vehicle can accommodate two litters when used as emergency field ambulance.

The Inventor

Inventor of the revolutionary Mighty Mite is an old-time pilot, barnstormer, and race driver who has spent thirty years studying safety devices on automobiles. He is Ben F. Gregory, whose original ideas made the Mighty Mite unique. Years ago he concluded that the wheels that steer a car should also drive it and pull it into turns. He successfully built and drove front-wheel-drive racing cars before abandoning auto designing for flying. It was not until 1946 that Mr. Gregory completed his first car with patented pivot center steering, individual wheel suspension, and front-wheel drive.

In a period of 4 years, the new car was satisfactorily tested over 100,000 miles. When shown films of the car's operation, the Marine Corps became interested.

Tests Continuing

Now, three years later, tests on the military model of Mr. Gregory's invention are continuing. One of the Mighty Mites demonstrated at Quantico had operated for 5,000 miles on a continuous 20-hour-per-day basis over varied terrain with a minimum pay load of 800 pounds. It is significant that, although tests have not been completed and the results are inconclusive, the vehicle is still running in top condition.

General Specifications

Below are general specification comparisons between the Mighty Mite and the Truck, ¼-ton, 4x4, Utility, M38A1 (jeep):

	Mighty Mite	*Jeep*
Pay load:		
Cross country	500 lbs.	800 lbs.
Highway	1,000 "	1,200 "
Curb weight	1,496 "	2,665 "
Wheel base	64½ ins.	81 ins.
Length	96 "	138⅜ "
Width	58 "	60⅞ "
Height	58 "	74⅞ "

When the Marine Corps became interested in the Mighty Mite it was "looking for a vehicle that could do anything a mule could." Apparently the search is ended.

An engineer, above, demonstrates ultrasonic cleaning of an aircraft carburetor.

Ultrasonics in Liquids

by

K. R. Newnham

AT the close of World War II, industry began to consider how it might turn some of its wartime skills and newly acquired knowledge to peacetime use. From such a transition has come one of industry's new and highly promising tools.

Problem Presented

As one consequence of its wartime activities for the military, the General Engineering Laboratory had on its staff a number of specialists in underwater sound techniques. It was decided to present this group with the problem of producing a device employing high-frequency sound or ultrasonics for peacetime application.

It was therefore decided to produce a device which would be capable of generating high-intensity, high-frequency sound in a liquid bath which would be suitable for use in laboratories engaged in research in the general field of ultrasonics.

Such investigations could conceivably lead to new methods or new processes for industry. The market for the device was considered to be colleges and universities and those industries which maintained laboratory staffs and facilities.

In designing equipment for this market the following specifications were set as minimum requirements. The equipment should be a single self-contained unit with no external connections except a power lead. The unit should operate from a 115-volt AC source. Controls and instruments should be kept to a minimum and the operator should not be required to make any adjustments other than to start the equipment and control the amount of power applied. A range of frequencies should be offered and the method of changing frequency should be simple and relatively quick to accomplish.

When the development got under way the decision was made to employ a piezoelectric crystal for the transducer or vibrating element. Because of its stable characteristics and availability, an X-cut quartz crystal, two inches in diameter was chosen. In order to provide a range of frequencies, crystals were cut to resonate at 300,000, 500,000, 750,000, and 1,000,000 cycles a second.

Circuit Developed

A power oscillator circuit was developed and coupled to the transducer by means of tank coils which were tuned to obtain maximum efficiency with each crystal.

The mechanical design was such that the transducer assembly evolved was extremely simple to assemble, and the tuning-coil assembly was of the plug-in type. How well the design specifications were met can be judged by a brief description of the resultant product.

A Single Unit

The General Electric ultrasonic generator is a single unit with over-all dimensions of 42 inches high, 22 inches wide, and 20 inches deep. The cabinet is of steel, and controls and instruments are arranged on a sloping panel for ease of operation and visibility and consist of two switches, a milliammeter, and an auto transformer for regulating the amount of power applied to the transducer.

The transducer assembly is fastened to the top of the cabinet. The outer housing is of a transparent material which permits observation of the crystal. The sound chamber is of metal, with the crystal forming part of the floor of the cavity into which the ultrasonic energy is directed.

The power oscillator is located on the floor of the cabinet, with the tank coil assembly just above it. Access is through a hinged door at the rear, which is adequately interlocked for safety.

Four frequencies are provided. To change frequency it is only necessary to remove the crystal from the trans-

ducer assembly, substituting another of the desired frequency, and to remove the tank coil assembly from the inside of the cabinet, substituting another assembly which has been matched to the new crystal. The only tools necessary are a common screwdriver and a small wrench, and the entire change can be made in less than ten minutes.

When the design had been approved, a single unit was put into operation. Ten more units were built immediately and were soon applied in laboratories, both in industry and in educational institutions.

Partially Filled

In operation the sound chamber is partially filled with liquid, usually common tap water. Voltage is applied to the quartz crystal which forms the center portion of the floor of the sound chamber, and the crystal expands and contracts at its natural frequency. The amplitude of this expansion and contraction is controlled by the voltage applied.

Particles of the liquid in the layer in contact with the crystal are violently accelerated when the crystal expands. This creates a much higher pressure than the ambient pressure of the rest of the liquid, and this high pressure is transmitted through the liquid, with very little dispersion, to the surface.

When the crystal contracts, a void tends to be formed between its surface and the liquid, and a negative pressure or vacuum is created. This causes a violent acceleration of the particles in a reverse direction.

The consequence of these violent and reversing accelerations of the liquid particles is that the entire column of liquid from the crystal to the surface is in a state of great agitation. At the surface, the appearance is one of boiling, even though the temperature is far below the boiling point. Drops of liquid are usually thrown out in a spray effect, and mist or fog is sometimes formed at the surface. Considerable heat is evolved.

Uses Discovered

Investigations made within the General Electric Company using this ultrasonic generator showed that it was useful for removing oil, grease, chips, dirt, etc., from metal. It was found that the degree of cleanliness obtained was usually superior to that of conventional methods.

In addition, the time required to obtain this result was usually only a small fraction of the normal cleaning cycle. This was particularly true when the pieces to be cleaned had blind or tapped holes, fine cracks or crevices, etc., which previously required hand brushing.

The cleaning effect is apparently accomplished by the extremely rapid pressure change on the surfaces of the part being cleaned. A scrubbing effect is produced by the fluctuating pressure waves which literally strip grease, dirt, oil, or foreign particles off the surfaces which are exposed to the agitated column of liquid above the crystal.

Because of the high frequency, the pressure waves are extremely short and thus are able to penetrate minute cracks, crevices, and holes which are inaccessible by conventional methods.

With this discovery, the attempt to handle larger and larger pieces and to adapt the equipment to mechanized handling led to minor modifications of the original design.

The design of the power supply was revised to insure that the equipment would be capable of continuous operation over long periods without breakdown. The efficiency of the equipment was also improved considerably.

Assembly Modified

The transducer assembly was modified so that the floor area of the sound chamber was increased to an area of approximately twelve square inches, or more than five times that of the original design. At the same time a new accessory was made available—an auxiliary tank or container fitted with a sump, the floor of which was an acoustic window.

The acoustic window transmitted the ultrasonic energy with very little loss, and the container could be made any shape and large enough to hold several gallons of solvent.

This made possible the cleaning of much larger pieces than had heretofore been possible.

The first industrial application of this particular ultrasonic equipment to cleaning was made early in 1951. This was an ultrasonic generator which was further modified to include a conveyor system for production work. This unit was used by an electric shaver manufacturer to clean shaver heads and replaced a hand brushing operation. The result was a marked reduction in cleaning costs and a greater degree of cleanliness than had been attained by other methods.

More Applications

The use of ultrasonics as a cleaning tool soon spread to other industries, particularly those manufacturing precision parts. Manufacturers of miniature ball bearings were early users of the equipment for cleaning their product.

The ever-growing list of industrial users now includes manufacturers of gyro equipment, aircraft carburetors, hypodermic needles, optical equipment, precision potentiometers, hydraulic assemblies, vacuum-tube components, slip-ring assemblies, and fine jewelry, to name only a few.

A note of caution should be injected, however. Ultrasonic cleaning in its present state is not the perfect answer to all cleaning problems. It is certainly not going to make all other cleaning methods obsolete. However in cleaning processes where a large amount of hand labor is required or where conventional cleaning is not adequate, ultrasonic cleaning offers great promise. When used in connection with or immediately following conventional methods, it has been phenomenally successful.

Future Is Promising

New and more powerful ultrasonic generators are being developed specifically for industrial applications. It is expected that with their development the variety of cleaning applications will be greatly expanded. In addition, new fields, such as mixing, decomposing, dyeing, plating, etc., may be opened up. The future for industry is extremely promising.

Mr. Newnham joined the staff of General Electric's General Engineering Laboratory, Schenectady, N. Y., in 1942. For the past several years he has been engaged in the development of ultrasonic equipment.

Rust Prevention Today

Volatile Corrosion Inhibitors Improve Military Packaging

Joseph Szanto

SINCE the appearance of the first article on volatile corrosion inhibitors in the September-October 1950 issue of ORDNANCE, these materials have gone through a period of considerable experimental application, and have emerged into the fields of industrial and military packaging as potent new tools for preservation in shipment and storage.

Study Was Simple

In the beginning, the study of these materials was relatively simple, since only one compound was commercially available; *i.e.*, dicyclohexylammonium nitrite, under the trade name of Shell VPI. With this one product it was possible to make a preliminary study of many problems thought to be peculiar to this type of preservative, and with these studies a program of full-scale experimental packaging was also initiated.

As a result of these studies certain definite requirements and conclusions were established, and on these a shop-use program was evolved. After approximately three years of gradually intensified production use at Springfield Armory, many problems associated with the purchase, storage, and use of volatile rust inhibitors have been reduced to a set of fairly simple instructions and precautions.

Instructions

Purchase Description 1000B includes a section covering these instructions, and a recent Navy specification, MIL-V-8574, covers the entire subject of storage and use of these inhibitor-coated papers and barrier laminates.

Briefly, storage of unused material must be in a cool, dry location, and original packages should not be opened until immediately before use. Inhibitor-treated packaging materials must be protected during shop use from excessive heat, moisture, and dirt, direct sunlight, and strong drafts.

To protect partially used rolls or boxed sheets of inhibitor paper during nonoperating periods, covers of greaseproof paper or moisture- and vaporproof barriers must be applied as complete overwraps in contact with the entire outer surfaces of the rolls or sheets.

Adequate protection is thus afforded for periods up to four days. In any cases of doubt, the outer sheets may be discarded since the success of this type of preservation depends largely on the provision of the designed amounts of inhibitors.

Preliminaries

Parts to be preserved must be cleaned, dried, and given a coating of some light preservative oil such as a material conforming to Spec. MIL-L-644. The inhibitor papers are best applied to these parts as complete wraps, with no metal surface farther from the inhibitor than twelve inches. With coated or backed types of inhibitor paper, the treated side of the sheet is applied toward the item being protected.

For military packaging, two levels of protection can be obtained with volatile-type inhibitors. In the immediate-use level, protection for a 3- to 6-month period is provided. Any approved type of outer container may be used over the inhibitor-paper-wrapped or covered item, and no special efforts need be devoted to sealing the container to prevent escape of vapors.

In the overseas-protection level, sealed containers fabricated of moisture- and vaporproof materials are required. Parts are wrapped in the inhibitor paper, and one or more such parts are then enclosed within the containers which may be of rigid (metal cans, treated fiberboard cans with metal ends), or flexible (moisture and vaporproof barrier bags) types.

Satisfactory Levels

Here an adequate amount of inhibitor is provided, and the containers will maintain satisfactory vapor levels over a period of many years, even under adverse conditions.

A group of rifle barrels wrapped in inhibitor paper four years ago and exposed in a covered open shed on the roof of a building in Springfield was recently examined and found to be free from rust. The inhibitor-paper wrap was folded and stapled but in no way sealed, and the barrels were exposed on a rack with no provision of exterior containers. Analysis of the paper for inhibitor loading showed that approximately one third of the original amount had been lost.

Used by Ordnance

At the present time, the Ordnance Corps uses packaging methods based on volatile-type inhibitors for all small arms and associated equipment, tools, and spare parts. These methods include various types of packs, ranging from individual units to bulk packaging.

In each case it was found advisable to revamp the entire package, starting with the methods of cleaning and preserving. These methods are presently described in the various purchase descriptions which have been prepared by the different mission arsenals.

Mr. Szanto has long been associated with the development of volatile corrosion inhibitors under the direction of the Ordnance Corps at Springfield Armory, Springfield, Mass.

Using the standard specification cleaning methods as listed in Spec. MIL-P-116, items are prepared for packaging by removal of all handling and shop residues, cutting compounds, and preservatives. In order to prevent possible harmful effects of acidic residues, chlorinated solvents are not generally used in the cleaning process.

Preservative Used

After cleaning, parts are immediately coated with a preservative oil, Spec. MIL-L-644. This oil not only protects the part until it is packaged, but also serves as an interim preservative within the package for the period during which the concentration of volatile inhibitor is building up to the effective minimum.

Where complicated shapes are involved, an appreciable time may elapse before interior surfaces can be effectively protected by the inhibitor vapors due to the slowness of the diffusion process, hence the provision of the preliminary preservative oil.

In the packaging operation, the parts are now packaged or wrapped with volatile-type inhibitor material. As a result of several years' experience at the armory in the use of inhibitor-treated papers, three main types have been found to cover adequately the current usages of this type of material.

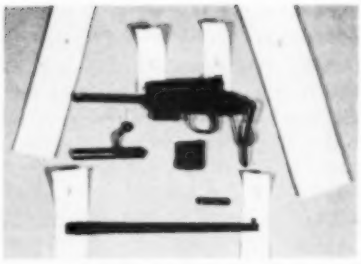
The first type is a treated neutral kraft paper, available in weights ranging from 30 to 60 pounds, flat or crêped. This paper is suitable for envelope liners, container liners, and as the least expensive means of applying the preservative for the immediate-use, short-term protection level.

Two Types of Barrier

Two types of laminated barrier sheets are also used. The first is a sheet of inhibitor paper laminated to a greaseproof paper conforming to Spec. MIL-B-121 Grade C. Being a more expensive material, this laminate is generally used for interior cushioning applications.

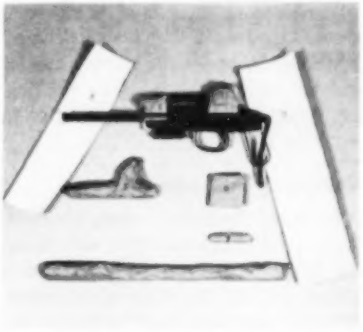
The second laminate consists of an inhibitor-treated paper-laminated to aluminum foil conforming to Spec. JAN-P-148 and embossed to aid in moldability. The foil laminate is best used for individual wrapping of parts later assembled into unit packs.

Both laminates are classed as moldable materials, which can be defined as materials which adhere to themselves upon folding, due either to an adhesive surface or to their ability to maintain a "dead fold." To achieve this "dead-fold" property, the sheet, upon folding, must have a minimum spring back or tendency to unfold.

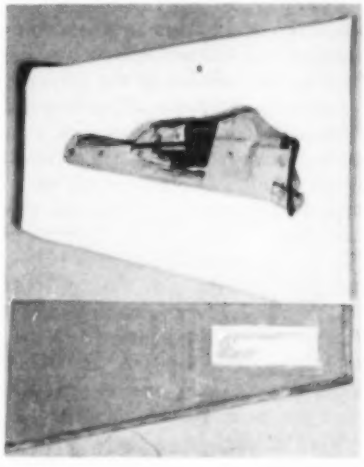


Above, disassembled M4 rifle and VPI cushioning strips ready for wrapping. Below, M4 cushioned for further wrapping.

Below, the M4 survival rifle in the third stage of VPI packaging sequence.



Below, ready for final VPI wrapper sheet and enclosure in waterproof bag shown.



One Principle Used

In the application of volatile-type preservatives to Ordnance packaging, a single principle has been used. To preserve the packaged item for the maximum period of time, the volatile inhibitor must remain continuously active.

This cannot be accomplished if the vapors are allowed to leave the package. By providing the best possible vapor barrier, the inhibitor will continue its action for the desired time.

The development of Ordnance packaging methods has thus dealt mainly with the application of suitable barriers and the prevention of damage to these barriers during the life of the package. Much attention has been paid to the problems of cushioning, dunnage, and methods of immobilizing items to prevent puncture of the vapor barrier.

The development of the two inhibitor paper laminates has aided considerably in the solution of this problem, but these are used as primary cushioning materials mainly with small items. For the larger pieces, such as entire weapons or large assemblies, additional cushioning has been found necessary.

As a result of several years' experience, the treatment of dunnage and cushioning materials has been reasonably worked out. Where the moldable-type inhibitor laminate serves as cushioning material, application of one or more layers, with the inhibitor-treated side facing the item, is satisfactory. In this way projections, sharp corners, and edges can be protected to prevent damage either to the part or to the package.

Typical Part

Packaging of a typical small part is the rear-sight elevating pinion for the M1 rifle. Each pinion is wrapped in a 4 by 5-inch square of moldable inhibitor paper large enough to allow adequate foldovers on the threaded end and the knurled knob. Twenty

wrapped pinions are then placed as a 2-row single tier in a heat-sealable moisture- and vaporproof bag which is inserted into two chipboard sleeves.

A further application of cushioning is found in the packaging of the caliber .22 M4 survival rifle (see illustrations on page 527). The disassembled weapon receives the cushioning strips in the order shown, two strips over the receiver, two strips to protect the ends of the barrel, and two larger strips to hold the barrel in place against the action.

Critical Areas Protected

The cushioned assembly is then inserted into a moisture- and vaporproof envelope which is heat-sealed. In spite of the number of small parts, the assembly is tight and all critical areas are well protected.

In the packaging of larger items such as complete weapons, two methods of protection for the barrier envelopes are in use. The floating-bag method, in which the item is suspended within the exterior container by means of mounting rods, requires little cushioning for the item itself.

Where this method cannot be used, as in small-arms weapons such as rifles, a multiple-cushioning system has been used with much success. In packaging the M1 rifle, two weapons, fully enclosed in a heat-sealed inhibitor paper-lined moisture- and vaporproof envelope conforming to Spec. MIL-B-131, Class 1, are placed in a corrugated fiberboard carton.

A separator of the same fiberboard material is placed in the center between the two envelopes. The ends of the latter are protected by a cushioning block, fabricated from a number of layers of fiberboard cut to shape and glued together.

Weight Distributed

No single layer of fiberboard is heavy or firm enough to protect the item, but the weight is so spread over large areas that a firm and tight package results.

Five of the 2-rifle cartons are then placed in the wood exterior container. This pack has an additional feature in that a 2-rifle carton can be used for domestic shipment at any time with safety.

Where larger blocks or spacers are required as dunnage, protection is required if this dunnage is used next to the item within the inhibitor-treated wrapping. Either a facing of inhibitor paper is placed between the item and the blocks or a complete wrap of inhibitor paper is applied around the dunnage.

One item which is shipped in large numbers is spare barrels for various small arms. A rapid and efficient packaging method has been evolved for these, using spiral-wound fiberboard tubes with metal ends.

A strip or tube of inhibitor paper is inserted in the bore of the barrel which is then wrapped in a sheet of foil laminate moldable inhibitor paper and inserted into the tube. The telescopic closure is sealed with vinyl plastic tape.

These packages are self-protecting and will withstand much abuse. The barrels are held rigidly within the container by spiral-wound supports which are integral with the tube interior.

In discussing the use of these volatile-type inhibitors, the emphasis has been on ferrous metals. The action of these inhibitors is specific for ferrous metals, and they are not intended for the protection of other metallic or nonmetallic materials.

Various Combinations

In many Ordnance items, however, various combinations exist, and in order to protect the ferrous surfaces comprising the major portion of the assembly some attention must be paid to the other materials comprising the remainder of the assembly.

Extensive testing has shown that aluminum or alclad combinations, stainless steel, nickel, and chromium surfaces are not affected by the inhibitor.

Copper and bronze alloys may be discolored slightly, and lead, zinc, cadmium, and magnesium are definitely attacked unless otherwise protected by some form of passive or protective surface film.

It is interesting to note that laboratory tests with the latter four materials do not generaliy check with actual packaging tests since these tests have, in the past, appeared to give better results—that is, less surface attack—than the more closely controlled laboratory tests.

Current packaging instructions allow the use of no more than minor amounts of these active metals with specific approval for each individual usage based on preliminary testing of the use in question.

A considerable amount of test work has also been done on the interaction of volatile-type inhibitors with plastics and resins such as are used in paints. Thermosetting resins of all types are not affected in any way by these inhibitors, nor are some thermoplastics.

Powder of Interest

Although the first available form of volatile rust inhibitors was as a fine powder, their subsequent use in treated papers has overshadowed the original form. Recently attention has again been focused on the powder, in particular as a preservative for intricate assemblies such as machine tools. To protect interior areas, where the application of treated paper is difficult or impossible, new techniques have been developed.

By the use of powder guns it is possible to apply inhibitor into gear cases, piping, and deep recesses, and reactivation of the machine at a later date does not require extensive disassembly.

This application has revived the original problem of dosage, which had been solved in the paper type of application due to the exact area loading of that material. Powder application by gun can be measured fairly accurately after preliminary tests of the equipment, but at the present time no standardized type is available, and each gun must be calibrated for delivery in grams of the powder per second.

Important By-products

A less-emphasized point, but one which has been long known, is that very often the item which has successfully withstood storage and transportation will finally be damaged during depreservation. It may be that the biggest economic gain from these inhibitors will be found to a great extent in the virtual elimination of the depreservation process. The other great economic gain will accrue from the more intensive use of cushioning and dunnage to prevent damage through unrestrained motion in transit. These by-products may, in the long run, turn out to be of equal value to the packaging method itself.

The huge size of the BARC is evident by comparison with the DUKW shown at the right (U. S. Army photos).

Amphibious Giant

The BARC May Replace the DUKW in Ship-to-Shore Support

Harry A. Jacobs

VETERANS of World War II amphibious operations in both the European and Pacific theaters have little difficulty in recalling the DUKW's which brought them and their supplies to the beachheads. Whether they took part in the assault on Sicily, Salerno, Anzio, Normandy, the Cote D'Azur, or any of the innumerable island hops in the Pacific, they won't forget the DUKW.

Ride Recalled

They remember dropping down on rope ladders from transports into the 2½-ton amphibious carriers which were snuggling against and bobbing up and down alongside the vessels. They can still feel it in the pit of their stomachs when they recall the picture of riding in toward the beach, huddled together on the bottom of these carryalls.

They will never forget how it felt when their DUKW hit the beach, rose out of the sea, and the wheels crunched into the sand as their conveyance changed from ship to vehicle.

They vividly recall that when the beachhead was secured and the assault waves had been landed how they depended upon these same carriers to bring them ammunition, weapons, equipment, clothing, food, and shelter. Then the doughty boat-truck became a vital link in the military supply line.

Mr. Jacobs served with the 4th Armored Division during the Normandy landings in World War II. He is now on the staff of the Executive Office, Office, Chief of Transportation, Department of the Army, Washington, D. C.

It changed from a personnel carrier into an indispensable cargo conveyor.

As long as the invading units were without built-up port facilities they depended to a large degree on the DUKW as the prime mover of supplies from ship to shore.

Army Satisfied

The Army was and still is well satisfied with the performance of the DUKW. For example, during the first four months after the invasion of France practically all supplies were moved in across the beaches. DUKW's alone carried approximately forty per cent of these supplies.

In fact, it is not conceivable how without them—in the absence of regular port facilities—our troops could have been adequately supplied until conventional sea terminals were captured and restored to service.

Even over a longer span of time, in which both port facilities and across-the-beach operations were employed, the DUKW carried a substantial share of the load. Thus from D-Day in Normandy in June 1944 to V-E Day in May 1945 a total of 15,500,000 long tons were handled at French and Belgian ports and across the beach. Of this total, over 3,000,000 long tons were delivered by DUKW's.

The DUKW proved to be one of the biggest surprises to Hitler's armies, for it helped to give us a freedom of movement for which they were not prepared. It enabled us to choose landing sites without undue emphasis on built-up port facilities.

Value Demonstrated

The impressive record of the World War II DUKW demonstrated the value of amphibious carriers and stimulated the Army in developing new amphibious equipment capable of handling military matériel and cargo across the beach, which heretofore was not feasible by existing amphibious vehicles.

Recently the Army Transportation Corps unveiled a 60-ton amphibian, baptized the BARC (barge, amphibious, resupply, cargo). At its first public demonstration at Fort Lawton, Wash., on November 25, 1952, the new vehicle was put through its paces and came off with flying colors.

An audience of Government, military, and industrial observers were deeply impressed when the monster vehicle carried simultaneously a 35-ton medium tank and a 35-ton heavy crane during an amphibious exercise. It traveled readily in the water, climbed the beach with obvious ease, and negotiated the soft sand with its heavy load to an inland point.

There it lowered its bow ramp, and the tank, followed by the crane, lumbered out ready for action. Then the BARC showed what it could do on land. It negotiated log obstacles freely, executed turns at all angles, and even climbed a 45-degree slope.

Subsequently, the BARC received its first launching test. It was dropped into the water, laterally, from temporary ways on a Seattle pier at a height of nineteen feet. The amphibian plunged into the water at a 30-degree angle and righted itself within a few seconds. Extensive surf trials and further launching tests were then held at Monterey, Calif. The BARC was later launched from the deck of an LST (landing ship, tank).

By coincidence, while the Monterey trials were under way, a sudden 60-mile gale beached six tuna boats. At the request of the Coast Guard, the BARC pushed and towed the craft back into the water and prevented a heavy financial loss to the boats' owners.

Monster Vehicle

The BARC is truly a monster vehicle. It stands 17½ feet high, is 61 feet long, and 27 feet wide. In a 36- x 14-foot cargo space it carries a normal pay load of 60 tons which in an emergency can be boosted to 100 tons. Its tires, the largest produced commercially, are almost 10 feet high.

The BARC's operating mechanism, the coördination of its seagoing and landlubbing features, and the over-all design reflect the many months of hard work which have gone into it as well as the ever-present American know-how and can-do.

The giant carrier moves over land on four tires, size 36 x 41. Each of these tires weighs more than 3,300 pounds; they contain sufficient rubber to produce more than 500 ordinary automobile tires.

The tires are not only unique because of their size but also because their pressure is centrally controlled by a hub inflation system. By moving a lever in the cab the driver can adjust tire pressure automatically at any time.

Deflatable Tires

On soft surfaces such as sand they may be deflated to provide additional traction. When hard ground is reached, pressure can be raised immediately without a stop, and more speedy movement becomes possible.

Each wheel is individually powered by a 165-horsepower Diesel engine which transmits its power through a torque converter. The power train consists of a torquematic transmission and two angle drives with planetary gear reduction from which the final drive is put into a ring gear mounted at the wheel's edge.

The transmission provides three forward speeds and one reverse. In high gear a maximum speed of fifteen miles an hour can be attained. Thanks to synchronized air controls, all four engines are shifted simultaneously.

Two 30-ton hydraulic rams mounted atop vertical king posts attached to the steering wheel are the main features of the steering mechanism. The vehicle can be maneuvered in three ways. In normal steering (just like in most automobiles) the rear wheels remain locked in a straight position while the front may be turned as desired. In full steering, like in large fire trucks, both front and rear wheels are moved, but at opposite angles.

Very Maneuverable

Finally, in "crab" steering both front and rear wheels are turned in the same direction. The three methods of steering provide the BARC with sufficient maneuverability to offset limitations imposed by its size.

The BARC is equally well equipped

After cruising with the ramp down, the BARC pumps water off the deck area.

for movement in water. Here it looks and acts like a self-propelled barge. When afloat it is driven by twin propellers under the stern. Two of the same four engines which power the wheels propel each screw. Each engine pair drives into a gathering box which, through a fluid coupling, transmits the power to marine reverse and reduction gears and thence to the propeller.

In this way the speed of the engines does not have to be carefully synchronized as power is being fed continuously from both ends through a fluid coupling.

Bilge Pumps

A bilge-pumping system with a capacity of 4,000 gallons of water a minute is another seagoing feature of the BARC. The pumps are powered through a take-off from the main drive shaft.

Just like on land, the BARC maneuvers very easily. Its sensitivity to control is similar to that of a small landing craft. By operating one propeller forward and the other in reverse, the BARC can spin in a relatively tight circle. It also can be steered by its propellers in case the rudder mechanism should fail.

Being primarily a cargo carrier, the amphibian is designed to facilitate the handling of supplies and equipment. Wheeled or tracked equipment and supplies which are readily transportable are discharged over a hydraulically operated bow ramp. A stern winch, driven through a power take-off, with a line-pull capacity of 50,000 pounds assists in handling heavy loads. Of course, cargo may be loaded directly into the cargo space by ship's tackle or cranes.

Floodlight System

In addition the BARC boasts of a floodlighting system for the cargo area, storage lockers located in the bow and stern and a flooding-type fire-extinguisher arrangement controllable from both the driver's cab and from the outside.

In spite of its huge size, a crew of three ordinarily manages the BARC. An operator drives or pilots the vehicle. He is aided by an assistant driver who also is the radio operator. A mechanic for routine maintenance and emergency repairs rounds up the crew.

A 4.00-6 lift-truck tire compared with the BARC tire shows vehicle's huge size.

The manpower requirement is low, thanks to simplicity in design and utilization of highly effective automatic equipment. The existence of easily manageable air controls, employing 7,000 feet of airlines, makes it possible for one driver to handle the carrier.

The crew can be housed in a cab on the bow atop the portside. The cab's canopy may be removed, thus lowering the vehicle's height.

Why the BARC?

What is the relationship between the DUKW and the BARC? If the DUKW proved so valuable during World War II, why did the Transportation Corps go to the expense and the trouble of developing the BARC? One need not look far for an answer. In fact, those familiar with the problems of over-the-beach supply already have the answer from the above description of the BARC's capability.

During World War II, military transportation experts recognized the major drawback of the DUKW—its limited cargo-carrying capacity. Its inability to haul bulky and heavy equipment also hindered logistic support of amphibious operations both in the assault and resupply phases.

Yet, because of its versatility, the DUKW was preferred to landing ships. The latter carry much greater loads, but the beach marks the end of their road. The DUKW, of course, travels also on land and thus eliminates ship-to-truck transfer at the waterline with an added advantage of preventing the beach area from becoming congested.

The answer to the problem of adequate over-the-beach logistic support hence lay in the development of an amphibious carrier which combined the hauling capacity of the landing craft with the versatility of the DUKW. This is what we have in the BARC. The BARC is basically a barge with wheels, whereas the DUKW is a truck with a hull.

Problems Posed

Projecting this idea into reality posed tremendous problems. It is obvious that building the DUKW proportioned to a larger scale was not the solution. In an engineering sense the BARC is *not* an oversize DUKW.

Development of the BARC involved extensive research and planning. Innumerable engineering problems, particularly in the marine field, had to be anticipated and resolved before the project reached the drawing-board stage.

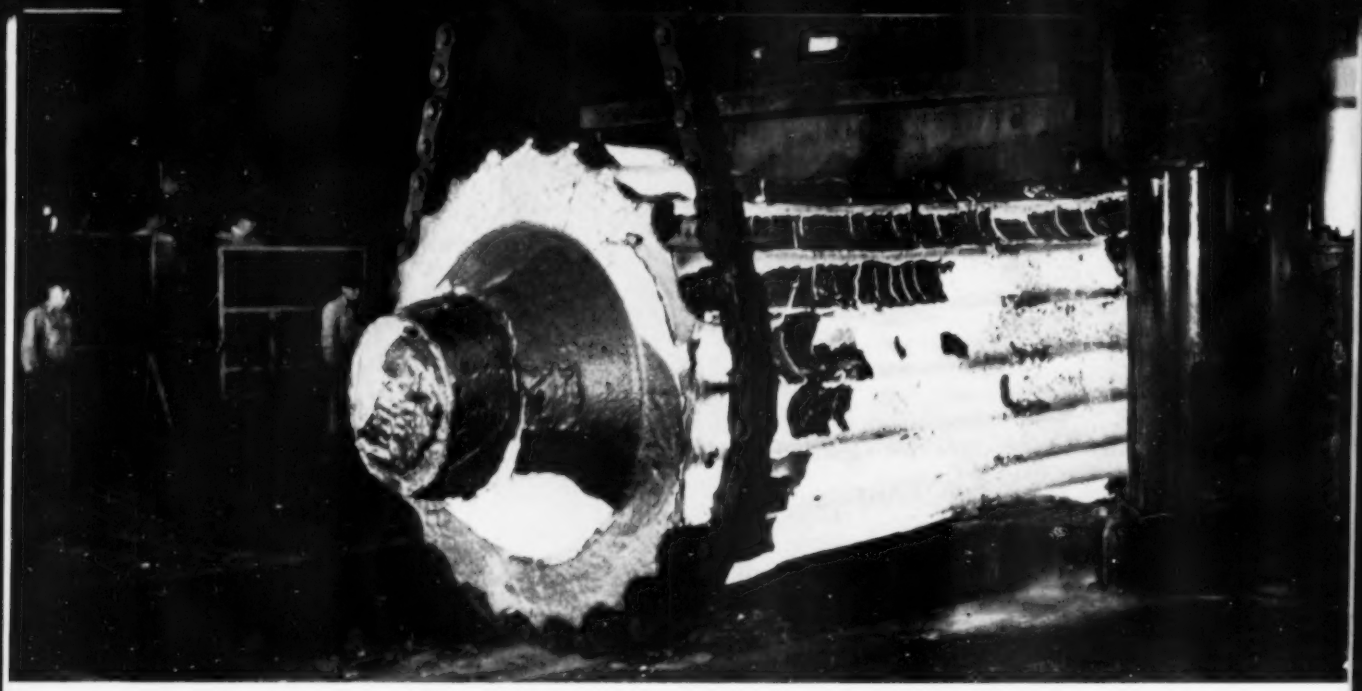
To find these answers the Transportation Corps engaged a number of highly qualified civilian consultants, each a specialist in his field. Working together, these men and Transportation Corps engineers determined the basic characteristics and design concept of a prototype. By December 1951 research had sufficiently advanced that a construction contract was let.

Research Continued

While construction progressed, research continued. Manufacturing problems had to be resolved carefully to retain congruency with the design concept. Yet only thirteen months elapsed from the evolution of the original concept to the complete construction of the first BARC model.

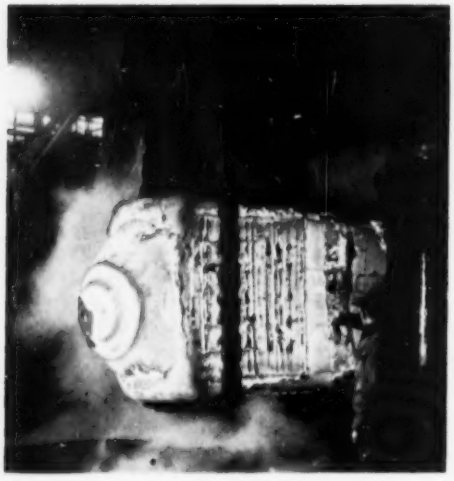
Once the BARC performs satisfactorily in all respects and its construction requirements have been refined to the lowest possible denominator, it will graduate from the experimental stage and will be ready to go on "active duty" with the Transportation Corps.

The Army will then command the services of a carrier capable of providing logistic support for amphibious operations far more efficiently and effectively than heretofore. The evolution of the BARC gives the Transportation Corps another tool designed for satisfying present and future military transportation demands.



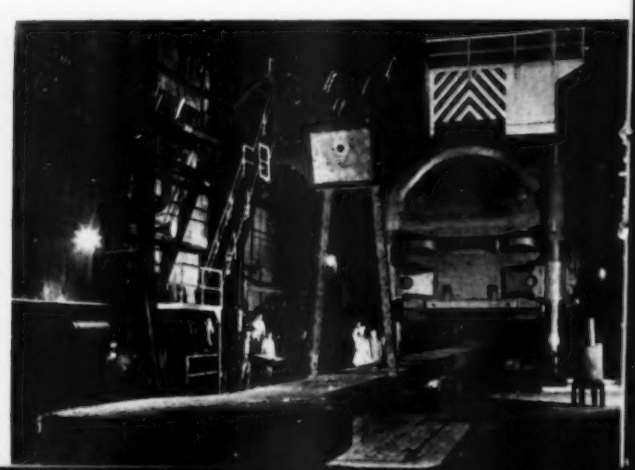
Biggest Forging

The world's longest steel forging—110 feet long and weighing 145 tons—was made recently by Bethlehem Steel Company, Bethlehem, Pa. It was one of 18 rectangular column sections for a giant 50,000-ton die forging press for airframe components. Beginning with a 275-ton ingot, shown above, the forging was completed after a series of 5 individual heating and forging operations under a 7,500-ton press. The accompanying illustrations show various steps in the process.



During second forging, above, the ingot is flattened and elongated. Below, the completed 110-foot forging is given final straightening.

At fourth forging, above, the column becomes 70 feet long and 44 inches wide. After final straightening, excess metal is trimmed off, below, with an automatic gas cutting machine that follows a chalked pattern.



Left, fork-lift truck moves part of a new Skysweeper unit into reusable steel container especially designed to house the complete fire-control assembly.

Packaging Ordnance

Unique Steel Containers Assure the Safe Transportation of Fragile Parts

Robert Dickey, III

PROBLEMS of packaging, handling, and transporting large complex assemblies for Army Ordnance have been solved by Sperry Gyroscope Company through the use of unique reusable steel containers adapted especially for the service.

The Sperry-manufactured fire-control system for the new 75-mm. Skysweeper "artillery machine gun," consists of several component parts which are assembled on arrival at military destinations. Because the unit is large—weighing about three tons—and contains fragile parts, Sperry's materials-handling department was assigned the task of developing a safe method for packing, handling, and shipping it.

Answer Found

After considerable research and study of all possible ways to solve this problem, the answer was found to be welded steel Transportainers, originally developed by Dravo Corporation for cargo protection in transoceanic shipping.

To meet Sperry's specific needs, the Dravo Transportainers were modified in dimension from the standard model and fitted with special channels and framework to receive the component parts of the units. A total of 120 of the special containers eventually will be in use by Sperry.

Results of the use of the big steel container are said to have exceeded original expectations. Numerous advantages have been realized by both Sperry and Army Ordnance.

If components of the assembly were packaged and crated separately—as they would have been if the container idea had not been adopted—a packing crew would take approximately two days to prepare one unit for shipment. Using the steel container, the same crew performs the operation in only 3 to 3½ hours.

In addition to this saving in time there have been substantial economies in packaging materials. No part of the assembly has to be wrapped or crated. Plastic covers are used for dust protection.

No lumber, nails, staples, paper, or any other packaging materials are used. This allows the carpenter shop to devote full time to other work. It also saves considerable floor space at the plant since no storage of lumber and materials is required on this project.

Mr. Dickey, now an executive of the Dravo Corporation, Pittsburgh, Pa., formerly served as a lieutenant commander in the experimental and development section of the Navy Bureau of Aëronautics.

Chances for errors in packing parts of the assembly have been eliminated by this method. Channels, metal baskets, and other fittings in the container are numbered to correspond with the parts they are designed to hold, and the physical design of the fittings is such that they can be used only for the parts they accommodate.

Errors Eliminated

Parts also are placed in the container in numerical sequence so that there is little possibility an assembly could be shipped incomplete. If components had to be crated and packed individually, there would be chances of error. One or more boxes containing components could be separated and lost in transit.

With all integral parts of the unit clearly marked and identified within the container, they can be removed at destination in proper sequence for immediate assembly. This not only eliminates time and expense of uncrating individual parts—during which some of them could be damaged—but it also does away with much sorting and

Compactly stowed in the steel container, all parts of the fire-control system are loaded in numerical sequence to assure quick assembly when removed.

checking. The plastic bags also are numbered to correspond with the parts they cover.

The Ordnance depot, moreover, is not required to develop special storage facilities for the assembly or its parts because they can be stored in the container, indoors or outdoors. Size and shape of the component parts would necessitate specially designed storage racks and fittings at depots if they were shipped individually.

Paper Work Eliminated

Considerable paper work has been eliminated both for Sperry and Ordnance personnel by this shipping method. Because all the component parts of the assembly are grouped in the container, packing slips used for separate packages are not needed. All the time and expense of marking the outside of individual packages and boxes is eliminated.

Once a container is loaded with the complete assembly, the entire unit is moved in a single operation by one lift truck. Each container is fitted with heavy-duty, wide flange wheels on the two rear corners for easy moving by the lift truck. The container also has lifting lugs at the four top corners for handling with a crane and sling.

At Sperry, the containers are moved on a ramp to the truck-loading dock where they are placed on flat-bed trucks. Design and dimensions of the container also make it suitable for transporting by railroad cars, ocean vessels, and inland-waterways barges.

To load a flat-bed truck with individually packed component parts for one assembly would require an estimated four times longer than loading a single container on the truck.

With each assembly compactly stowed in the container, one flat-bed truck can carry three units. If the parts were individually crated, only two complete units could be transported on the same size truck.

Although the steel containers are reshipped or "deadheaded" back to the Sperry plant from the Ordnance depot after the assemblies have been removed, total cost of shipping them both ways does not differ appreciably from an ordinary one-way shipment. Measuring the round-trip shipping costs against the many savings resulting from the use of the container, extra expense of the return shipment is negligible.

Safety in Transit

Perhaps the outstanding advantage of this new shipping idea is the protection afforded the assembly when it is transported in the container. Being of welded steel construction, the container is scientifically designed to withstand the stresses and strains that develop during ocean shipments. Special fittings and framework which secure component parts inside the container protect the parts against impact damage from bumps. The entire container is handled as a single unit, thus limiting to one the chances of dropping it.

Additional protection for the unit is provided by the weatherproof construction of the container. It may be stored or transported in the open without damage to the contents.

Information Guarded

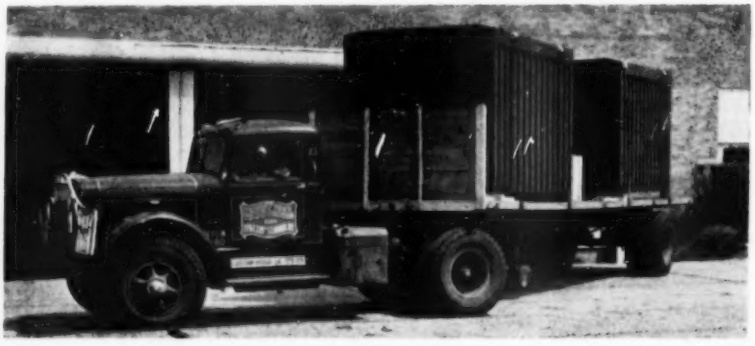
From the standpoint of safeguarding military information about the assembly, the Transportainer shipping method is well adapted. When locked and sealed, the container is virtually a "jumbo safety deposit vault." It does not have to be identified outside as wooden crates would have to be. There is no chance for pilferage of any small parts or packages. This latter feature is one of the main advantages steamship lines have reported for the containers.

Standard model Transportainers, as developed by Dravo Corporation, have a 275 cubic-foot capacity, with the following outside dimensions: 7 feet, 9 inches long; 6 feet, 5 inches wide; and 6 feet, 5½ inches high.

Walls are made of 14-gauge steel with vertical corrugations for reënforcement. The floor is of double thickness of 14-gauge steel. The roof utilizes 16- and 18-gauge steel.

EDITOR'S NOTE.—Another article on ordnance packaging appears on page 526 of this issue ("Rust Prevention Today," by Joseph Szanto). Other ORDNANCE articles on this subject were "Protective Packaging," by D. N. Hauseman on page 174 of the July-August 1953 issue and "Defeating Corrosion," by A. R. Black and A. Wachter on page 1052 of the May-June 1953 issue.

Ready for transportation to military destinations, weathertight Transportainers containing complete fire-control units are loaded on flat-bed trailers.



Index of Advertisements

NOVEMBER-DECEMBER 1953

The following companies have shown by their interest in the Industry-Ordnance Team that they are ready to serve the United States through industrial preparednes for national security and peace. Such companies as these are indicative of the industrial strength of the Nation upon which the military might of the armed forces depends in peace and war. Their production for the peacetime needs of America can be converted to meet national requirements in an emergency.

	Page
Abbott Ball Company	512
AC Spark Plug Division, GMC	499
Aerial Products, Inc.	461
Aetna-Standard Engineering Company	470
Allis-Chalmers Manufacturing Company	496
Allison Division, GMC	391
Aluminum Company of America	471
Alvey-Ferguson Company	514
American Chain & Cable Company	388
American Chemical Paint Company	442
American Locomotive Company	482
American Machine & Foundry Company	490
Ampex Electric Corporation	505
Amplex Manufacturing Company	453
Arma Corporation	IV Cover
Armstrong Cork Company	513
Arnold Engineering Company	483
Barnes Company, W. F. and John	486
Bassick Company	474
Bayshore Industries, Inc.	509
Beaird Company, J. B.	500
Bell Telephone Laboratories	363
Bendix Aviation Corporation	367, 472, 477
Bijur Lubricating Corporation	446
Blaw-Knox Company	373
Breeze Corporations, Inc.	452
Brown & Sharpe Manufacturing Company	466
Buffalo Forge Company	497
Bundy Tubing Company	377
Burgess-Norton Manufacturing Company	505
Cameron Iron Works, Inc.	480
Caterpillar Tractor Company	362
Chase Brass & Copper Company	498
Chrysler Corporation	372
Clark Equipment Company	447
Cleveland Container Company	440
Continental Motors Corporation	384
Danly Machine Specialties, Inc.	389
Dempster Brothers, Inc.	378
Du Pont de Nemours & Company, E. I.	536
Eastern Tool & Manufacturing Company	451
Eaton Manufacturing Company	468
Evans' Sons, Inc., John	512
Exact Weight Scale Company	513
Fairchild Engine & Airplane Corporation	463, Facing 489
Follows Gear Shaper Company	507
Ford Instrument Company, Division Sperry Corporation	374
Fuller Brush Company	510
Geuder, Paeschke & Frey Company	476
Gottscho, Inc., Adolph	462
Gray Manufacturing Company	502
Great Lakes Steel Corporation	376
Gulf Oil Corporation	508
Heckethorn Manufacturing & Supply Company	379
Heil Company	508
Hobart Manufacturing Company	364
Hydraulic Press Manufacturing Company	441
Industrial Electrical Works	509
International Business Machines Corporation	366
International Harvester Company	491
International Nickel Company	494
Jennison-Wright Corporation	443
Kelsey-Hayes Wheel Company	445
Ketay Manufacturing Corporation	387
King-Seeley Corporation	508
Kollmorgen Optical Company	510
Koppers Company	369
Kwikset Locks, Inc.	457
Lapointe Machine Tool Company	371
Link-Belt Company	478
Luria Engineering Corporation	503
Lycoming Divisions—Avco Manufacturing Corporation	475
Magnetic Metals Company	390
Markem Machine Company	444
Marmon-Herrington Company	365
Mason & Hanger Company	509
Maxson Corporation, W. L.	460
McCord Corporation	507
Midland Steel Products Company	370
Minneapolis-Moline Company	515
National Malleable & Steel Castings Company	386
National Tube Division, U. S. Steel Corporation	514
Neilson Chemical Company	515
New Departure Division, GMC	516
New York Air Brake Company	485
Niagara Blower Company	507
North American Aviation, Inc.	504
Oakite Products, Inc.	385
Olin Industries, Inc.	512
Optical Gaging Products, Inc.	489
Parker Rust Proof Company	510
Pioneer Engineering & Manufacturing Company	464
Pittsburgh Plate Glass Company	449
Precision Castings Company	484
Pressed Steel Car Company	465
Protective Coatings, Inc.	506
Remington Arms Company	506
Remington Rand Inc.	495
Reo Motors, Inc.	501
Rheem Manufacturing Company	459
Riverside Foundry	479
Rockwell Manufacturing Company	458
Rolock, Inc.	456
Sheffield Corporation	473
Silent Glow Oil Burner Corporation	481
Sperry Gyroscope Company	368
Spicer Manufacturing Division, Dana Corporation,	Facing 456, 457
Standard Tube Company	448
Steel Products Engineering Company	492
Strom Steel Ball Company	460
Stromberg-Carlson Company	493
Surface Combustion Corporation	487
Tenney Engineering, Inc.	454
Timken-Detroit Axle Company	375
Timken Roller Bearing Company	III Cover
Triplex Industries, Inc.	II Cover
Tube Reducing Corporation	380
Tung-Sol Electric, Inc.	513
Underwood Corporation	450
United Chromium, Inc.	382
United Engineering and Foundry Company	Facing 488
Waterbury Farrel Foundry & Machine Company	515
Watson-Stillman Company	469
Wirebound Box Manufacturers Association	383
Wolverine Tube Division, Calumet & Hecla, Inc.	488

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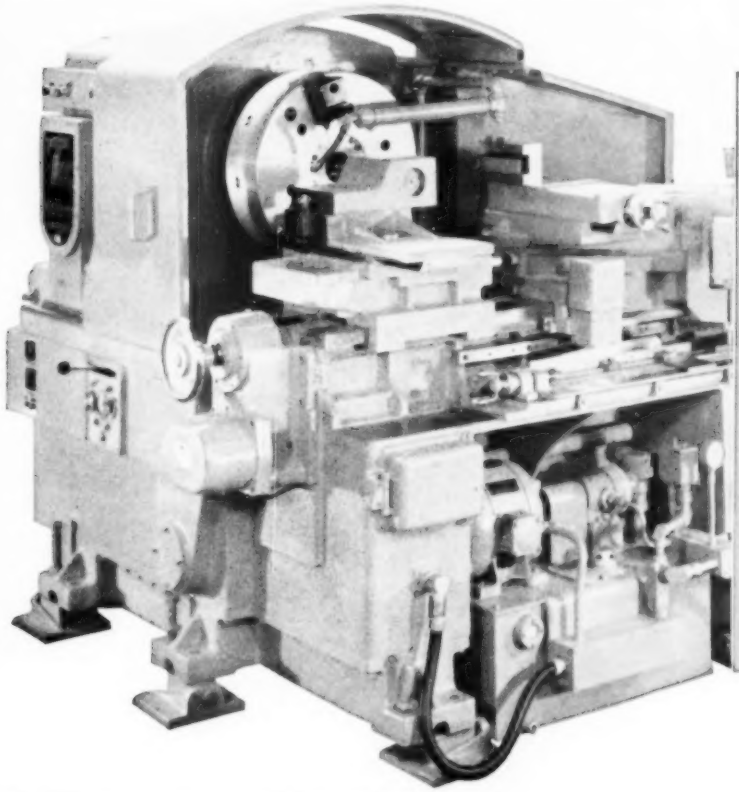
SPEED, precision and automatic operation—these are the machining qualities built into Lodge & Shipley's new 30″ T-Matic. With the bed at right angles to the spindle, it face contours, bores, turns big parts with small-lathe accuracy.

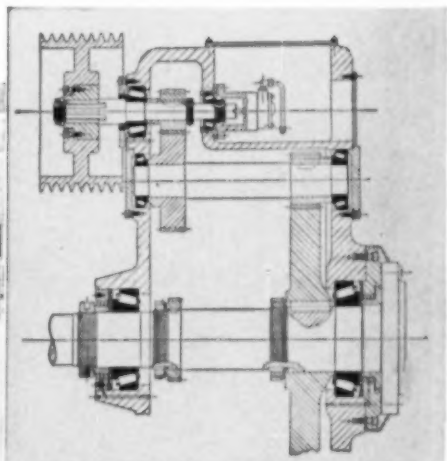
Since all the T-Lathe's work is single chucked, the spindle must be completely free of end play. Otherwise face contouring accuracy would be affected. Any wobble or chatter in the spindle would be doubled or tripled near the outside of large diameter parts.

For these reasons, Lodge & Shipley mounted the spindle on 2 Timken® bearings. Their tapered rollers are preloaded during assembly, eliminating both end and side play. Since the spindle must support large work pieces, these are large diameter bearings. Yet their run-out never exceeds three ten-thousandths of an inch (.0003″).

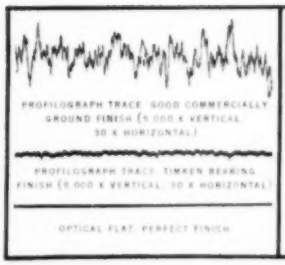
Made of the Timken Company's own fine alloy steel, Timken bearings normally last the life of the machine tool they're a part of. Building or buying machines, specify "Timken". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.





How **THE LODGE & SHIPLEY COMPANY** mounts T-Lathe spindle on Timken bearings to get accuracy needed for delicate work on large diameter pieces.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PROFILOGRAPH TRACE: TIMKEN BEARING FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)
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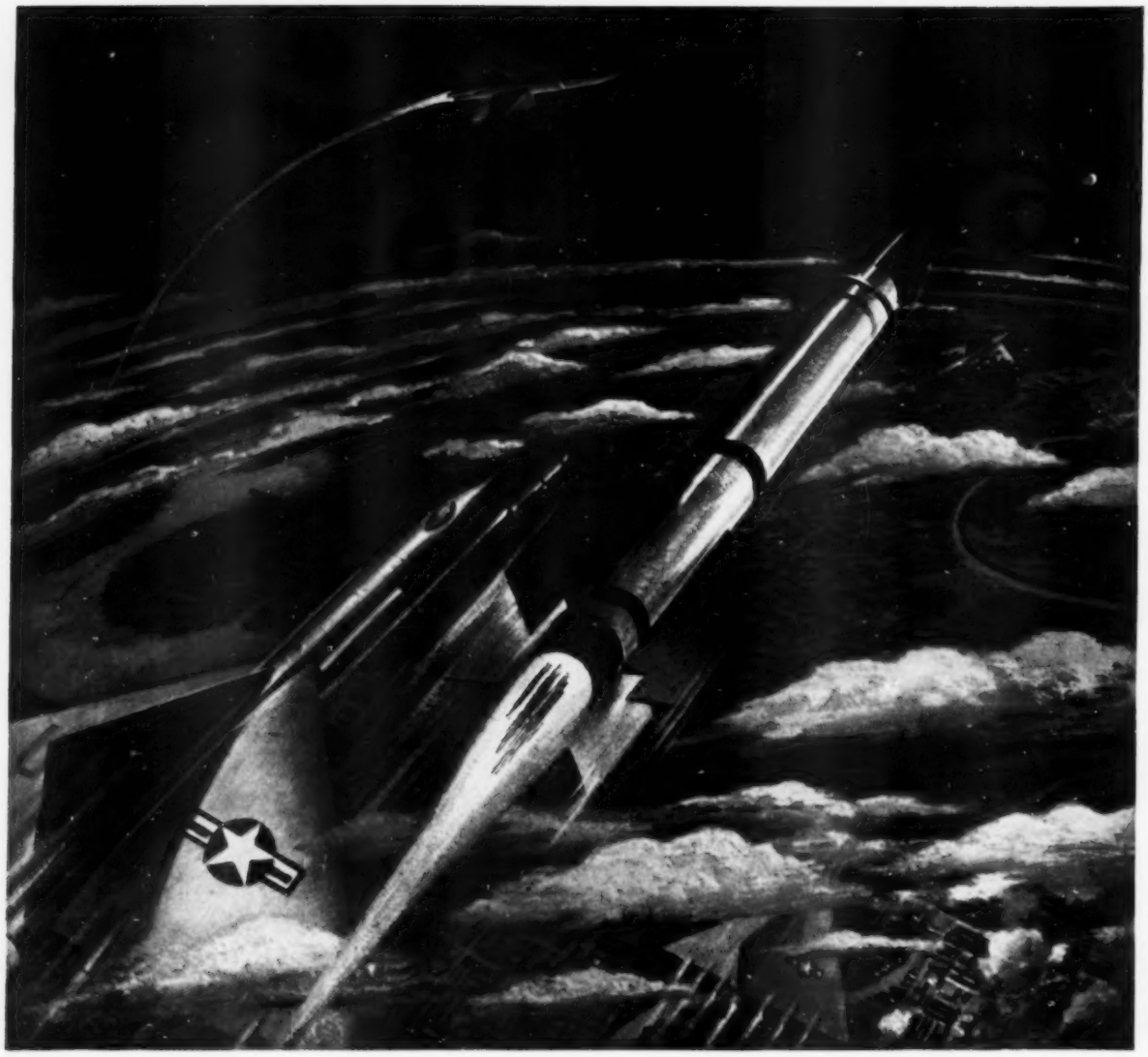

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